LOW-LEVEL WASTE DISPOSAL FACILITY FEDERAL REVIEW GROUP MANUAL

REVISION 3

JUNE 2008

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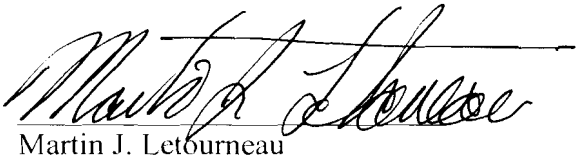
Concurrence

The Low-Level Waste Disposal Facility Federal Review Group Manual, Revision 3, is approved for use as of the most recent date below.



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LLW Disposal Facility Federal Review Group Manual Revision History

This Revision 3 of the Low-Level Waste Disposal Facility Federal Review Group (LFRG) Manual was prepared primarily to include review criteria for the review of transuranic (TRU) waste disposal subject to 40 CFR 191 (see Section 3.2). The previously separate Transuranic Waste Disposal Federal Review Group Manual and the LFRG Manual have been combined in this manual because of the many similarities in the review and approval processes required by DOE Manual 435.1-1 for low-level waste (LLW) and TRU waste disposal. The presentation of the two very similar processes in this document will facilitate identification of the common elements of the review and approval processes and the criteria for LLW and TRU disposal. The sharing of review experience and lessons learned between these closely related review communities is expected to strengthen the review and approval processes for both waste types.

Revision 2 of the LFRG Manual was prepared primarily to address redundancy in the technical review criteria for LLW disposal which are in Section 3.1. Over the course of several reviews, the LFRG noted that the technical review criteria, although thorough, were repetitive. The LFRG chairman commissioned a team of LFRG members and contractor specialists to propose revisions to the review criteria. The proposed criteria were then reviewed and approved by the LFRG.

Revision 2 also included designation of the appropriate deputy assistant secretary to approve candidates nominated for LFRG membership, incorporation of some minor editorial changes, deletion of selected appendices where updated examples are posted on the LFRG web page, addition of the LFRG Qualification Standard, and revision of the Disposal Authorization Statement Section (i.e., Section 4).

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List of Acronyms and Abbreviations

ALARA	As Low As Reasonably Achievable
CA	Composite Analysis
CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act
DAS	Disposal Authorization Statement
DNFSB	Defense Nuclear Facilities Safety Board
DOE	U.S. Department of Energy
DOE O	U.S. Department of Energy Order
DOE M	U.S. Department of Energy Manual
DSA	Documented Safety Analysis
D&D	Decontamination and Decommissioning
EM	Office of Environmental Management
FUSRAP	Formerly Utilized Sites Remedial Action Program
HS	Office of Health, Safety, and Security
LFRG	Low-Level Waste Disposal Facility Federal Review Group
LLW	Low-Level Radioactive Waste
NNSA	National Nuclear Security Administration
NRC	U.S. Nuclear Regulatory Commission
ORR	Operational Readiness Review
OSHA	Occupational Safety and Health Act
QA	Quality Assurance
PA	Performance Assessment
RCRA	Resource Conservation and Recovery Act of 1976
ROD	Record of Decision
SA	Special Analyses
TRU	Transuranic
WAC	Waste Acceptance Criteria
WIPP	Waste Isolation Pilot Plant

1. INTRODUCTION

The Department of Energy (DOE) and the National Nuclear Security Administration (NNSA) are responsible and have the regulatory authority for designing, constructing, operating, and closing low-level waste (LLW) disposal facilities in a manner that is protective of workers, the public, and the environment. DOE has the regulatory authority as the implementing agency for the disposal of TRU waste in locations other than the Waste Isolation Pilot Plant (WIPP). In order to provide a reasonable expectation that disposal of LLW and TRU will provide this protection in the long term, disposal facility operators prepare documentation to satisfy the requirements of DOE O 435.1 and 40 CFR 191, Subpart B including Performance Assessments (PAs) and Composite Analyses (CAs).

Required by DOE Order (O) 435.1/40 CFR 191, these documents help establish design features and operating constraints that promote compliance with the order's performance objectives and related performance measures. Performance Assessments are analyses of LLW/TRU disposal facilities performed to demonstrate that there is a reasonable expectation that the long-term performance objectives for a disposal facility will be satisfied. Composite analyses are used as a planning tool to analyze the potential offsite impact of a LLW disposal facility in combination with other radioactive source terms that are expected to remain at the site. The Department of Energy has the responsibility for reviewing and approving these radiological assessments utilizing DOE Order 435.1 and 40 CFR 191 as appropriate. The review and approval functions are performed by DOE/NNSA and field organizations.

Following approval of the PA and CA for a disposal facility, a Disposal Authorization Statement (DAS) is prepared for approval by DOE Headquarters. The process for development of this key document and its content is also described in this manual.

1.1 Low-Level Waste Disposal Facility Federal Review Group (LFRG)

On June 27, 1997, the Deputy Assistant Secretaries for Waste Management and Environmental Restoration in the Office of Environmental Management (EM) established the LFRG to develop and implement a review process for LLW disposal facility PAs and CAs. The LFRG is charged with providing management with the necessary information to determine if LLW and TRU waste disposal facilities are designed, constructed, operated, maintained, and closed in a manner that protects the public and environment. The approved LFRG charter appears in Appendix A. DOE Order 435.1 also requires that specific DOE-HQ Deputy Assistant Secretaries establish a process similar to that used for LLW disposal facilities for review and approval of PAs for TRU waste disposal facilities at sites other than WIPP. The LFRG is now responsible for reviewing and approving PAs and CAs for TRU disposal facilities.

DOE/NNSA management officials are responsible for the approval of PAs and CAs in accordance with DOE O 435.1/40 CFR 191. The establishment of the LFRG assigned the responsibility to Federal employees for reviewing PAs and CAs, determining compliance with performance objectives and measures, and recommending the approval of PAs and CAs. Establishing the LFRG also centralized the LLW/TRU disposal facility PA and CA review process to fulfill DOE regulatory oversight responsibilities.

The LFRG consists of federal employees from DOE headquarters and field organizations. Members are selected to ensure the LFRG reflects the policy, technical, regulatory, and programmatic perspectives necessary to conduct effective PA and CA reviews. LFRG members are approved by the LFRG Chair and the appropriate DAS or Associate Deputy Administrator (EM/NNSA). Appendix E delineates the technical qualifications to be considered when appointing members to the LFRG.

1.2 Purpose and Organization of this Manual

This manual provides guidance for conducting reviews of DOE LLW and TRU disposal facility PAs and CAs (including revisions) in accordance with DOE O 435.1 and 40 CFR 191. Reviews shall be performed in accordance with these procedures and guidance. The LFRG is responsible for conducting the reviews for DOE LLW and TRU disposal facilities of different designs and with varying potential for impacting public safety and health and the environment. The guidance provided by this manual is intended to provide consistency in the conduct of and products from the review process. Review procedures and document formats may be modified, as appropriate, to address specific site conditions. Modifications to the procedures and formats contained in the guidance manual should be documented in the site-specific PA and/or CA review plans described in Chapter 2.

This manual is also intended to aid DOE program offices, DOE field offices, and the site contractors in understanding and preparing for the review of their PAs and CAs, as well as participating in the PA and CA review processes. The manual also serves as a means of informing other interested agencies and parties of the DOE processes for reviewing PAs and CAs.

The approved PA and CA for a facility are key documents that support the granting of a disposal authorization statement for a disposal facility. This LFRG manual also provides guidance on the preparation and approval of such DASs.

Reviewers who use this manual should report any feedback on or suggestions for improvement in the review process to the LFRG. Reviewers and personnel at the site being reviewed should be encouraged by the LFRG and the reviewers to provide this feedback. The LFRG should consider these critiques and develop updates to this LFRG Manual as appropriate.

1.3 Purpose of PAs and CAs

PAs are conducted to demonstrate that there is a reasonable expectation that LLW or TRU disposed at DOE LLW or TRU facilities, respectively, will not exceed the performance objectives contained in DOE Manual (DOE M) 435.1, Radioactive Waste Management, and/or requirements of 40 CFR 191, Environmental Protection Standards for the Management and Disposal of Spent Nuclear Fuel, High-Level and Transuranic Radioactive Wastes and related measures associated with protection of the public from the inappropriate management of LLW and TRU.

The three performance objectives imposed by DOE M 435.1-1 for LLW are:

1) Dose to representative members of the public shall not exceed 25 mrem (0.25mSv) in a year total effective dose equivalent from all exposure pathways excluding the dose from radon and its progeny in air.

2) Dose to representative members of the public via the air pathway shall not exceed 10 mrem (0.10 mSv) in a year total effective dose equivalent, excluding the dose from radon and its progeny.

3) Release of radon shall be less than an average flux of 20 pCi/m^2/sec (0.74 Bq/m^2/sec) at the surface of the disposal facility. Alternatively, a limit of 0.5 pCi/l (0.0185 Bq/l) of air may be applied at the boundary of the facility.

DOE M 435.1-1 also requires, for purposes of establishing limits on radionuclides that may be disposed of near-surface, an assessment of impacts to water resources and an assessment of impacts calculated for a hypothetical person assumed to intrude inadvertently for a temporary period (up to one year) into the LLW disposal facility. The intruder analyses shall use performance measures for chronic and acute exposure scenarios, respectively, of 100 mrem (1 mSv) in a year and 500 mrem (5 mSv) total effective dose equivalent excluding radon in air.

Performance assessments for TRU must demonstrate a reasonable expectation that TRU waste disposal facilities will meet the following 40 CFR 191 requirements:

1) 40 CFR 191.13, Containment Requirements
2) 40 CFR 191.14, Assurance Requirements
3) 40 CFR 191.15, Individual Protection Requirements
4) 40 CFR 191.16 or 191.24, Groundwater Protection Requirements

Composite analyses are conducted to assess possible impacts of multiple sources, including the disposal facility, on long-term compliance with DOE environmental and public radiation protection requirements contained in DOE O 5400.5, *Radiation Protection of the Public and the Environment*. The purpose of the analysis is to facilitate planning and land use decisions that help assure that the authorization of the disposal facility will not result in long-term compliance problems, and should potential problems be identified, to determine management alternatives and corrective actions or assessment needs. The CA is not a document that is prepared for the purpose of demonstrating compliance with DOE's primary dose limit for protection of the public. The analysis is a planning tool intended to provide a reasonable expectation that current LLW disposal activities will not result in the need for future corrective or remedial actions to protect the public and environment.

This process for TRU waste disposal parallels the process developed for DOE LLW disposal facilities and requires that the transuranic waste disposal system be included in a composite analysis in addition to complying with the requirements of 40 CFR 191. The composite analysis is a DOE requirement, separate from the performance assessment. Its purpose is to assess possible impacts from multiple radioactive sources, including the transuranic waste disposal

system, on long-term compliance with DOE environmental and public radiation protection requirements contained in DOE Order 5400.5. The composite analysis is not required for determining compliance with the 40 CFR 191 environmental standards, but it is an expected part of the analyses that DOE considers when determining compliance with DOE O 435.1.

1.4 Purpose of PA and CA Review

The goal of the review process is to promote complete and comprehensive documents supported by appropriate rationale that demonstrate regulatory compliance, reflect the site- and facility-specific conditions, and are, therefore, defensible. The reviews are performed to provide management with reasonable expectation that the applicable performance objectives and measures will be met. The reviews provide the basis for accepting the PA and/or CA, and for issuing DASs in accordance with section 1.7. The DAS represents headquarters approval of the PA and/or CA, and includes conditions deemed necessary to provide long-term protection of the public and environment from the LLW/TRU disposal facility.

1.5 Purpose of the Disposal Authorization Statement

Disposal authorization statement is the ultimate document verifying that the required assessments have been performed and that they support the conclusion that there is a reasonable expectation that the LLW/TRU disposal performance objectives, measures, and requirements will be satisfied. The disposal authorization statement is functionally a Federal permit. It also documents limits on design, construction, operations and closure for the subject disposal facility. Approval of a DAS is also based on review of five facility-specific documents: (1) the PA; (2) the CA; (3) the maintenance plan for the PA and CA; (4) the closure plan; and (5) the monitoring plan.

1.6 Scope of the PA and CA Reviews

Each PA and/or CA review will be a focused, site-specific review of technical, regulatory, and programmatic adequacy. The complex-wide representation of federal staff enhances DOE's LLW and TRU line management capabilities by providing a mechanism for transferring lessons learned from site to site.

1.7 Radiological Assessment Review Process

LFRG Review Teams are convened to conduct reviews in a manner conceptually similar to DOE's processes for review of Documented Safety Analyses (DSAs) and for conducting Operational Readiness Reviews (ORRs). The PA and CA review teams are comprised of federal employees who should meet specific qualifications identified in Appendix E for their area of expertise. Teams may be supplemented with qualified consulting contractors as appropriate (i.e., to provide technical assistance, or expertise not readily available in DOE) that are approved by the LFRG.

The principal activities and products comprising a PA and CA review are:

- acknowledge suitability for review.

- assemble a radiological PA/CA team,
- develop a PA/CA review plan,
- review the LLW or TRU disposal facility PA and CA,
- conduct site visits, meetings, and interrogatories,
- compile a PA/CA review report,
- develop a compliance evaluation, and
- conduct and document a lessons learned evaluation.

Figure 1-1 shows the major activities comprising the PA and CA review process. The PA and CA review process begins with a determination by the LFRG site representative that the PA or CA is complete and suitable for review. If this determination is affirmative, the LFRG selects a PA and/or CA review team leader from a site other than the site submitting the PA/CA. The review team leader recommends candidate team members and areas of responsibility for the review to the LFRG for oral approval. Following team selection, the review team prepares a detailed review plan for conducting the specific PA and/or CA review for LFRG approval.

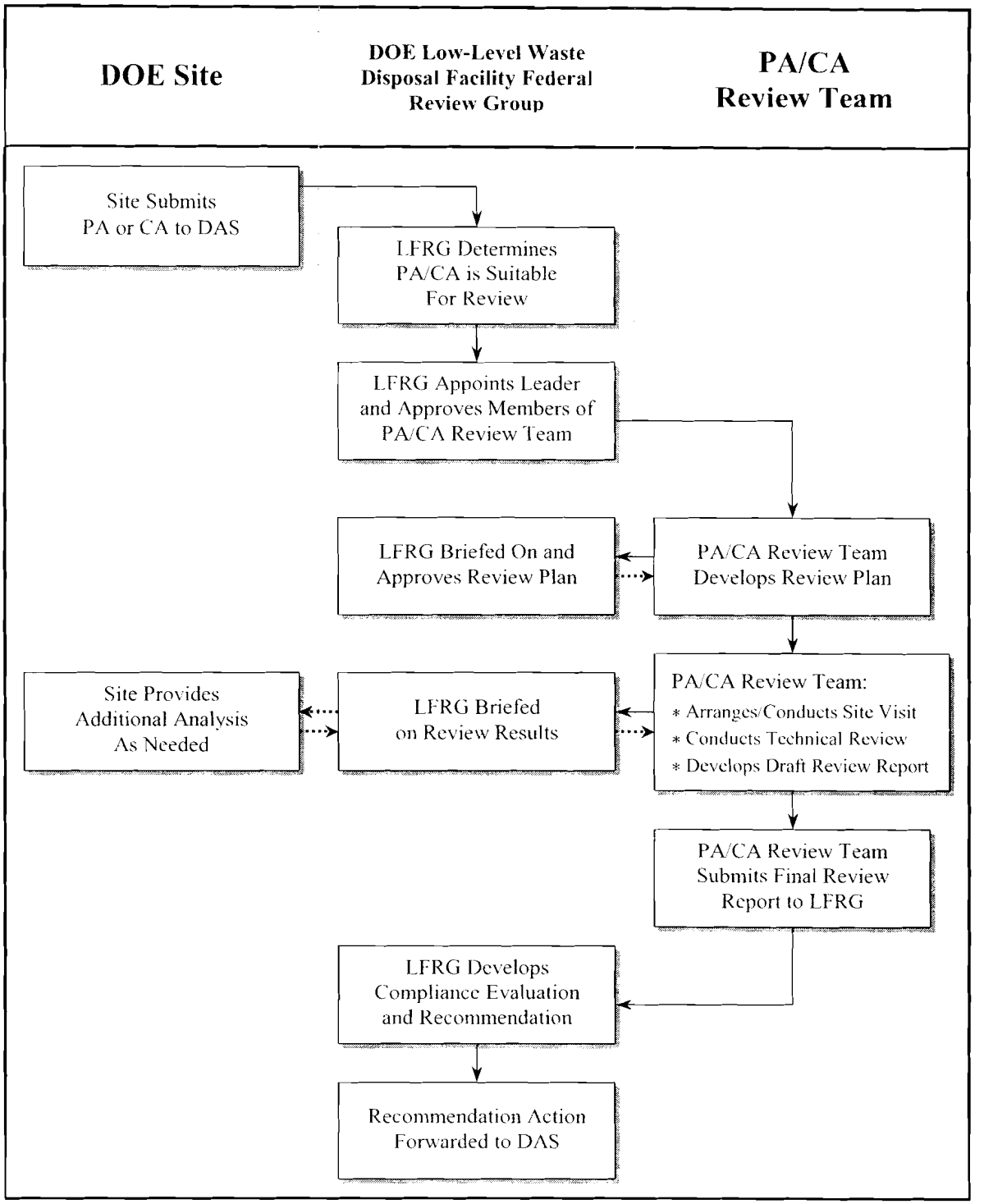


Figure 1-1: Major Activities Conducted During PA/CA Review

The PA/CA review team should conduct the technical review of the PA and/or CA by evaluating the PA and/or CA against the criteria in Section 3.1 of this manual for LLW PAs, Section 3.2 for TRU PAs, and Section 3.3 for CAs. The review includes a site visit and review of other site documentation, if necessary. The review team prepares a review report and recommends to the LFRG that the PA and/or CA be accepted, accepted with conditions, or not accepted.

The LFRG prepares a compliance evaluation that either accepts or rejects the review team's recommendation. Management will consider the LFRG compliance evaluation during the review and approval of the DAS, which is prepared by the LFRG. Once a disposal facility is granted a DAS, the facility must operate within the DAS or pursue a revision to it. The DAS may/may not require a revision during the PA/CA revision cycle. The LFRG will make this determination (to revise the DAS or not) during the review and approval process of the disposal site's PA/CA.

The elapsed time from conducting PA and/or CA reviews, through issuing final PA and/or CA review reports could take several months. The duration of the review is affected by the lines of inquiry pursued by the review team. During the course of the review, additional information may be requested from the PA or CA preparers to support the assessment and its conclusions. The LFRG may continue involvement with other activities associated with preparation of the compliance evaluation and the DAS including maintenance updates by the sites, and records maintenance.

2. RADIOLOGICAL ASSESSMENT REVIEW PROCESS

This chapter describes the administrative process and the basic technical framework under which the LFRG administers the initial/revision reviews of radiological assessments (PAs and CAs) and formulates conclusions. Key planning steps, basic duties, and responsible individuals are identified. The administrative procedures and the basic technical framework will help ensure consistency among review teams in conducting and documenting the reviews of radiological assessments.

2.1 Establishing Suitability for Review

Upon receipt of a radiological assessment, the LFRG site representative evaluates the document to determine if it is suitable for review. This evaluation determines if sufficient information is present for a review team to conduct an effective technical review. To expedite the review process, this initial evaluation can take place concurrently with the establishment of the review team.

2.2 Establishing a Review Team

The LFRG begins the establishment of a review team by selecting a review team leader. Potential team leaders must be Federal employees and may come from a list of technically qualified DOE personnel maintained by the LFRG or may be a DOE employee nominated by a member of the LFRG. In selecting a review team leader, the LFRG considers the document type (PA/CA) and magnitude of the revision (major or minor), the site- or facility-specific conditions and characteristics, and the capabilities of the candidates. The review team leader cannot be from the site presenting a PA/CA for LFRG review. The review team leader performs a review of the radiological assessment and prepares a list of potential candidates for review team members. The review team leader proposes the review team members to the LFRG and any contractor technical specialists or consultants that will be needed in the review and they are then selected with the concurrence of the LFRG Chair.

2.2.1 Team Membership

Review team members are federal personnel and contractor specialists selected for their technical qualifications and their knowledge and experience related to radiological assessment reviews; their knowledge of the important technical and regulatory disciplines underpinning the specific PA and/or CA to be reviewed; their technical and programmatic review experience; their demonstrated technical and managerial leadership skills; and their communication skills. A team member cannot be from the site presenting the PA/CA for LFRG review. Appendix E provides the review team leader with a list of technical qualification he/she can use in the review team member selection process. At least one member of each team shall be a voting LFRG member.

At least one staff member from the DOE field office with responsibility over the PA and/or CA being reviewed is to serve as a liaison to the review team to provide first hand knowledge of the site being evaluated. As a liaison, this person provides the necessary contacts to arrange site visits, provide documents if requested, and answer questions about the radiological assessment.

Generally, the areas of expertise to be represented on a review team include, but are not limited to, hydrology, geology, hydrogeology, health physics, radiological exposure analysis (e.g., pathways analysis, conceptual modeling, computer code evaluation, dose effects), chemistry, civil engineering (e.g., concrete degradation, evaluations of disposal facility engineering features), waste management, DOE directive compliance, Quality Assurance (QA) and waste form stability.

2.2.2 Conflicts of Interest

Sensitivity to potential conflicts of interest must be considered when selecting personnel for specific radiological assessment review teams. Persons will not be asked to review their own work or work for which the independence of their judgment might be adversely influenced. In evaluating potential review team members, the review team leader should consider:

• whether the person has ever been employed, directly or indirectly (e.g., through subcontract) at the site under review. If yes, what is/was the timing and nature of that employment?

• whether the person is involved in waste management at a facility or site that has a generator-disposer relationship with the site under review. (What are the person's relevant responsibilities?)

• whether the person has been involved in development of any models that are used for performing PA or CA modeling. If yes, what models and are those models used in the radiological assessment under review?

• whether the person was materially involved in the preparation of any part of the analysis under review (e.g., providing data, developing models, performing analyses, writing, reviewing). If yes, what was the nature of the person's involvement?

Federal employee members of the review teams are reminded that they remain subject to the

conflicts of interest statutes and regulations that apply to all DOE employees. Members will be requested to sign a "Confidentiality and Conflict of Interest Certification."

2.3 Review Team Responsibilities

The responsibilities of each person supporting a review team are discussed in this section.

Team Leader

The review team leader manages the review team and serves as the primary contact point between the LFRG and the site representatives. The review team leader's principal responsibilities are to:

1) Ensure commitment of time and travel funds, as necessary, from the relevant manager or from the LFRG Chair to support the review effort. The office employing the review team leader is asked to pay for the team leader's time and travel.

2) Select and familiarize review team staff including identifying and recruiting qualified DOE personnel as members and contractors as supplemental technical consultants, as necessary to meet the objectives of the review, with the concurrence of the LFRG Chair.

3) Identify and address any conflict of interest issues for review team members and technical consultants.

4) Manage and provide guidance to the review team staff concerning the overall review process and methodology, documentation requirements, draft and final review reports, review team meetings, and schedules.

5) Develop a review plan that describes site visits, review approach, review products, necessary documents, and review milestones and schedules.

6) Coordinate and manage review team discussions, site visits, and meetings.

7) Coordinate communications among the review team leader, review team members and consultants, and the LFRG. Coordinate activities of review team members and consultants so the results of the review are integrated.

8) Serve as the point of contact for information requests regarding review team activities and reports.

9) Inform review team staff of any DOE Headquarters policy and/or program changes and other pertinent information that could affect the review process or schedule.

10) Compile the review report. Ensure the report is accurate, objective, and thorough. Ensure that sufficient copies of the final review reports are printed and delivered to the LFRG, appropriate DOE offices, and others.

11) Ensure, with assistance from the DOE liaison from the site under review, that all pertinent documentation is placed into the administrative record during the review. Maintain the administrative record and any other records and files associated with review team activities, and provide them to the LFRG with the review report.

12) Ensure, with assistance from the DOE liaison from the site under review, that progress on completion of any follow-up commitments (e.g., review of a report required by a condition contained in a DAS), LFRG recommendations, or other planned actions are tracked and reported to the LFRG until completed.

If desired, the review team leader may appoint another individual to act as a review team coordinator and delegate responsibilities to the coordinator. If appointed, the coordinator reports directly to the review team leader throughout the review.

Team Members

The review team members' responsibilities are to:

1) Confirm the review assignments with the review team leader.

2) Evaluate the radiological assessment against the criteria applicable to his/her assignment and the scope of the review contained in Section 3 of this manual.

3) Provide the results of the radiological assessment review to the review team leader. Ensure that the results are accurately reflected in the review report.

4) Review any follow-up documentation as requested by the review team leader or the LFRG.

Team Consultants

The team consultants may be review team members or may serve as non-member resources and their responsibilities are to:

1) Confirm the review assignments with the review team leader.

2) Evaluate the technical area(s) of the radiological assessment for technical adequacy consistent with his/her assignment and the scope of the review.

3) Provide the results of the radiological assessment technical area review to the review team leader.

4) Review any follow-up documentation as requested by the review team leader or the LFRG.

Interaction with Regulatory Agencies and Others

External regulatory agencies (e.g., federal/state environmental protection agencies), or other

interested parties, may express an interest in the review of a radiological assessment for a specific DOE site or LLW/TRU disposal facility. Recognizing the Department's commitment to open interactions with external entities, the LFRG, the review team leader, and site management are responsible for determining the best means of establishing an effective interface, as appropriate. Options for interfacing with external entities include providing progress reports, both written and oral, and extending an opportunity to participate with the review team as an observer.

2.4 Review Administrative Process

The administrative process established to conduct a radiological assessment review will: coordinate the activities of the LFRG and a Review Team; facilitate the interactions of the Review Team and the site and facility being evaluated; and establish a complete record of the review. An example review plan is provided by accessing the LFRG web page.

PA/CA Review Plan

Prior to the review, the review team prepares a review plan to coordinate the activities of the review process. Key elements of the review plan are:

- General review approach;
- Planned specific activities;
- Review schedule and milestones;
- Review team leader, members, and technical specialists identification;
- Administrative record requirements;
- Supporting data and documents to be reviewed;
- EM QA Program implementation plans;
- Orientation plans for review team members;
- Modifications or additions to the standard review criteria; and
- Plans for health and safety protection of the review team.

Administrative Record

The review team leader establishes an administrative record for documenting the review and the review's results. All records associated with the review, including the PA, CA, Review Plan, site visit interactions and results, correspondence, technical documents, meeting minutes, briefing packages, review team member qualifications, and conflict of interest avoidance information

become part of the administrative record. The administrative record is subject to, and administered under, the EM QA Program protocols. If possible, the administrative record should contain the originals of all documents.

The administrative record is assembled and maintained by the review team leader during the review and is turned over to the LFRG when the review report is submitted.

Quality Assurance

Radiological assessment review activities are performed in conformance with the requirements of the DOE O 414.1C, *Quality Assurance*, and 40 CFR 191 as appropriate.

2.5 Site Visit

All members and consultants of the review team will usually benefit from a site visit. At a minimum, this visit should include an orientation of the site and facility evaluated, and the radiological assessment under review, a tour of the site and facility, and meetings with knowledgeable site and facility personnel to exchange information about the facility, PA and/or CA.

2.5.1 Pre-Site Visit Activities

Prior to an initial site visit, the review team performs a preliminary review of the radiological assessment. The preliminary review is intended to: 1) confirm that the document is complete and ready for a comprehensive review; 2) determine if the review team has the collective expertise to perform a comprehensive review; and 3) identify information in the radiological assessment that requires discussion during the site visit. The findings of this preliminary review may be used to determine whether additional technical expertise and/or information are needed.

The preliminary review may include a review of past studies, assessments, reports, sampling and monitoring data, and other pertinent documents the review team needs to gain an understanding of site operations and existing or potential problem areas. A key role of the DOE liaison from the site under review is to identify and review federal, state, and local statutes or regulations that are relevant to the review, including any site-specific requirements or guidance documents relevant to the information in the radiological assessment.

2.5.2 Site Visit Preparation

In order to maximize the benefit of site visits, the review team leader and members should be thoroughly prepared. Proper preparation should include but not be limited to:

1) Coordination of Site Activities and Information Needs

The review team leader should contact the appropriate field office and site representatives to determine specific dates and logistics for a site visit.

After the dates and logistics for a site visit have been finalized, the review team leader will notify

the LFRG Chair. A copy of the review plan should be provided to the LFRG Chair, team members, and to the site representative.

2) Security and Health and Safety Planning

As part of the preparation for the site visit and tour, the review team leader should coordinate the information flow to ensure that security badges are ready for attendees and that any other security or clearance matters are handled prior to arrival at the site. The site personnel coordinating the visit should provide the necessary papers, documents, and site logistics required to accomplish these important steps when arranging a visit.

Also, as part of preparation for the review site visit, the review team leader needs to ensure that necessary health and safety planning is performed. If the review team members are going to be walking in or around areas under which the Occupational Safety and Health Act (OSHA) health and safety and/or other regulations apply, the review team leader needs to ensure that the necessary training or training waivers and other paperwork have been arranged with site personnel.

3) Agenda

The review team leader, along with the site representative, develops a detailed agenda for the site visit. A list of topics to be covered and issues to be considered during the review is developed based on the preliminary review of the radiological assessment. The details of the agenda, with logistics and appropriate attendees, should be worked with the site and facility contacts, and finalized at least five days prior to the visit. The review team leader should ensure that all parties attending the meetings receive the agenda in advance of the visit.

2.5.3 Site Visit Activities

In order to maximize the benefit of the site visit for all participants, the review team should consider accomplishing the following actions:

1) Meetings

The site visit provides the opportunity for meetings of the review team in which they can share technical information gathered during the visit and to discuss remaining site visit activities. Meetings with preparers of the radiological assessment and other cognizant site and facility personnel also provide opportunities for exchange of information relevant to the PA and CA review. To the extent possible, the need for these meetings is identified prior to the site visit, coordinated appropriately, and scheduled on the agenda. The review team leader should brief the site representative and appropriate site management of any findings or items of interest at the end of each day. This will allow the site to resolve those findings or items of interest, if possible, prior to the Review Team's closeout meeting.

2) Closeout Briefing

The review team leader provides a closeout briefing for the site personnel before the review team

leaves the site. This briefing provides an opportunity to discuss notable practices, findings, observations, and for final questions and answers. Also at this point, any need for further documentation, site tours, technical meetings, and information exchanges with technical personnel can be identified and discussed.

2.6 PA/CA Technical Reviews

The principal purpose of the review team's activities is to perform detailed technical reviews of PAs and/or CAs. Based on the reviews, the LFRG will formulate conclusions on whether there is compliance with requirements of DOE O 435.1 or 40 CFR 191, as appropriate. The LFRG may make recommendations about operations at the facilities based upon the technical review.

The detailed technical review of a PA and CA is to: (1) identify whether required information is present; (2) determine if the information presented is correct and applicable; and (3) determine if the analysis supports the conclusions. To that end, the PA and CA are reviewed against criteria to determine whether they are adequate and acceptable.

Section 3 provides the basic framework and technical criteria for the reviews of LLW and TRU PAs and CAs. The review team should use the Section 3 criteria as well as other documents such as: "Format and Content Guide for U.S. DOE Low-Level Waste Disposal Facility Performance Assessment and Composite Analyses"; and Appendix C to 40 CFR 191, "Guidance for Implementation of Subpart B" in establishing the review criteria for the site submitting the PA/CA for review and approval. Review findings represent broad conclusions reached on the PA or CA. Detailed acceptance criteria are included to apply to specific topics and discussions in the PA and CA in order to support the findings. Minimum information expected in either the PA or CA to support the analysis, is provided in the guidance.

Following the review, the review team members determine whether the conclusions reached in the PA and/or CA are acceptable and supportable. The review team documents its findings in a report (discussed in detail in Section 2.8).

2.7 Additional Technical Information

Additional questions may arise as the review team is developing conclusions on the PA and/or CA. The review team should solicit additional technical information requested in accordance with the acceptance criteria presented in Section 3. Additional information requested by the review team should be in the form of existing data or information. The review team leader should solicit the assistance of the DOE field office liaison in obtaining additional information and analysis.

The review team should not solicit additional PA or CA evaluations (e.g., a complete PA calculation to determine the results of an alternative scenario). If this type of additional evaluation is required, it should only be requested by the LFRG as a condition of acceptance of the PA or CA based on the conclusions of the review team on the existing PA and/or CA evaluations.

Additional information needs, requests, and meetings are to be documented and become part of the administrative record.

2.8 Key and Secondary Issues

The significant issues identified by a review team are categorized as "key" issues and "secondary" issues. Key issues are those which the team determines must be resolved for the review team to recommend acceptance of the PA or CA under review. The review team should identify which review criteria are associated with each key issue and those criteria must be reported as not met in the review criterion matrix. If the site can resolve one or more of the key issues prior to completion of the review report, the review team should revise the review report to reflect that additional work by the site. If the site does not resolve the key issues prior to completion of the review report, the review team may recommend that a conditional disposal authorization statement be issued with explicit conditions requiring that the key issues be resolved by dates certain.

Secondary issues are those which the review team determines may be resolved via the normal PA/CA maintenance program. The review team should identify which review criteria are associated with each secondary issue and those criteria must be reported as not met in the review criterion matrix. The site may attempt to resolve one or more of the secondary issues prior to completion of the review report, and any such progress should be reported in the review report. Resolution of any remaining secondary issues can be addressed by a single disposal authorization statement condition requiring that a plan and schedule be prepared and implemented for addressing the secondary issues.

The review team may choose also to report observations and identify less important issues that provide opportunities for improvement in the PA or CA. These issues and observations may be reported in the review matrix for criteria that are designated as met or those designated as not met because of key or related issues. The site is not required to act on these observations and opportunities for improvement.

2.9 Review Report

Following the technical review, the review team prepares a review report. The report summarizes the findings, technical adequacy and completeness of the radiological assessment, the issues identified from the review and their resolution, and any issues that were not resolved. The review team should include as appendices, supplemental information and/or documentation deemed necessary to understanding the review. The review report should include all of the information from the review needed to provide the basis for the LFRG's compliance evaluation (see Section 2.9) of the radiological assessment.

The following guidance is provided in two parts. First, guidance is provided on the PA review report. Separate guidance is provided on the CA review report. If a review team has the opportunity to simultaneously review the PA and CA for a LLW or TRU disposal facility, then the two parts of the guidance could be combined to create one review report.

2.9.1 PA Review Report Outline

A suggested PA review report outline is as follows:

i *Executive Summary*
1.0 *Introduction*
2.0 *Summary of Site and Facility Description*
3.0 *Summary of PA Review*
4.0 *Technical Adequacy of PA*
5.0 *Consistency of PA*
6.0 *Unresolved Issues*
7.0 *Recommendation of Review Team*
8.0 *Appendices*
- *A. Review Team Members and Consultants and Their Qualifications*
- *B. Review Plan*
- *C. Chronology of Review*
- *D. Comments from Review Team Members*
- *E. List of Important Communications between Site and Review Team*
- *F. List of Supporting Documentation Utilized During the Review*
- *G. Review Criteria Matrix*

The following sections address these suggested elements of a PA review report.

2.9.2 PA Review Report Development

The conclusions of the PA review with respect to the criteria presented in Section 3 are to be addressed in a review report. This guidance is not intended to provide a comprehensive discussion applicable to all PAs. Instead, the review team should customize their report under the headings suggested in the outline and provide a concise reflection of the PA review conducted. The review report should include references to the PA and any related documentation. The conclusion of the review report should include a recommendation that the PA be accepted, accepted with conditions, or not accepted. Once submitted to the LFRG in final, no changes should be made to the review report.

1.0 *Introduction*

This section provides a brief introduction on the purpose of the report, and includes a citation of the PA being reviewed and the guidance used to conduct the review. There should also be a concise statement of the review process and review team findings, as well as an overview of the report contents.

2.0 *Summary of Site and Facility Description*

This section provides a concise description of the LLW disposal facility addressed in the PA, including the surrounding site. The material in this section can be extracted from the PA and presented as background to review report readers unfamiliar with the site and disposal facility.

3.0 *Summary of PA Review*

This section provides an overview of the PA review. Any documentation from the site that was prepared in response to requests from the review team should be briefly discussed. Issues identified during the course of the review and the resolution of those issues should be discussed in this section.

The conclusions of the review are presented in this section. References to any appendices for extended discussions contained in the minutes of the meetings of the review team are appropriate. References to appendices that identify the members and consultants on the review team, and the chronology of the review is also appropriate.

4.0 *Technical Adequacy of PA*

This section provides discussion of the following aspects of the PA:

- A summary of the method of analysis and the calculated results.
- The review determination is the assessment is complete, thorough and technically supported and that conclusions are valid and acceptable.
- Major issues relating to the technical adequacy of the PA (and assurance requirements for TRU disposal); and
- The basis for concluding the PA is technically adequate and that there is a reasonable expectation that performance objectives and measures of DOE M 435.1-1/40 CFR 191 will be met.

5.0 *Consistency of PA*

This section documents the consistency of the PA and any additional material developed in the review with the Format and Content Guide for U.S. Department of Energy Low-Level Waste Disposal Facility Performance Assessments and Composite Analyses or other documents. Discussion of how the guidance was interpreted for the PA, and a judgment on the consistency of approach taken with respect to: the PA guidance; existing laws; regulations (40 CFR 191); DOE directives; DOE policy; and any applicable agreements with regulatory agencies or affected states. Conflicts with other competing regulatory matters should be identified and the approach taken in the PA in addressing these conflicts identified. The significance of any inconsistencies with respect to the acceptance of the PA should be discussed.

6.0 *Unresolved Issues*

This section identifies any issues which were not satisfactorily or completely resolved during the PA review. Most issues can be expected to be resolved in the course of the review through requests for additional information or during discussions between the review team and the DOE site. Some issues may remain unresolved for lack of sufficient data or knowledge, or due to competing policies or regulatory directives. Some review team members may enter dissenting opinions on parts of the review, and these should be discussed in this section. The significance of unresolved issues on the recommendation to the LFRG should be identified and discussed.

Because many unresolved issues may pertain to uncertainties involved in decision-making, assumptions made, and difficulty in agreeing or disagreeing with findings based on calculations far into the future; the PA maintenance program required by DOE M 435.1-1 can be used as an effective method for resolving these issues. Identification of studies to reduce uncertainty, analysis to justify assumptions, and collection of data over time are examples of conditions that should be considered for inclusion in the recommendation specifically as part of the facility's PA maintenance program. Recommendations for conditions on the PA maintenance program may allow the facility to continue operating while the uncertainties are studied.

7.0 Recommendation of Review Team

The review team must recommend that the PA be accepted, accepted with conditions, or not accepted. The basis for the recommendation should be provided, including references to the relevant material in the review report.

If the review team recommends the PA be accepted, this signifies that all issues concerning the results of the PA and any relationship to Waste Acceptance Criteria (WAC), disposal facility operations, the PA maintenance program, and any other elements of the management of LLW/TRU were resolved. This also means that documentation in the administrative record is complete and the Review Team could identify no additional conditions that need to be placed in the DAS beyond those that have already been addressed in the section of the PA and resolved.

If the review team recommends the PA be accepted with conditions, then the review team has identified some issues that could not be resolved to their full satisfaction, or has identified operational constraints, further analysis, monitoring, or reporting that should be identified as conditions in the DAS. Conditions on the acceptance of the PA should be explicitly stated, with reference to the justifications for the conditions clearly identified in the materials reviewed and placed in the administrative record.

If the team recommends the PA not be accepted, then the review team has identified major issues which could not be resolved through the development and implementation of any conditions on the facility operations, waste acceptance, monitoring, or reporting. This condition would require additional rounds of review, therefore, the review report should clearly lay out the issues that cannot be resolved, the reasons they cannot be resolved, and any comments that provide assistance to the PA developers and the site/facility that would allow for a finding of acceptance.

Appendices

Appendices should be used to reduce the review report's length and provide references to important information used in the PA review.

Appendix A should include a list of the review team members and any consultants and their qualifications.

Appendix B should be the review plan used for the PA review.

Appendix C should include a chronology of the PA review that lists all communications, meetings, and other events which occurred as part of the review.

Appendix D should contain review team member comments or dissenting opinions which need to be reflected in the review report.

Appendix E should include all written communications (e.g. the site's self assessment versus the review criteria, between the DOE site and the review team that are considered germane to the conclusions of the review.

Appendix F should list any supporting documentation provided by the site for the PA review or used by the review team in making the conclusions of the review.

Appendix G review criteria matrix with review team comments.

This documentation should include any material developed in response to questions posed by the review team. Additional appendices may be added to the review report as appropriate.

2.9.3 CA Review Report Outline

A suggested CA review report outline follows:

i *Executive Summary*
1.0 *Introduction*
2.0 *Summary of Facility Description and Interacting Sources*
3.0 *Summary of CA Review*
4.0 *Technical Adequacy of CA*
5.0 *Consistency of CA*
6.0 *Unresolved Issues*
7.0 *Recommendation of Review Team*
8.0 *Appendices*
- *A. Review Team Members and Qualifications*
- *B. Review Plan*
- *C. Chronology of Review*
- *D. Comments from Review Team Members*

E. *List of Important Communications Between Site and Review Team*
F. *List of Supporting Documentation Utilized During the Review*
G. *Review Criteria Matrix*

These suggested elements of a CA Review Report are described below.

2.9.4 CA Review Report Development

The results of the CA review using the guidance presented in Section 3 are to be addressed in a review report. This guidance is not intended to provide a comprehensive discussion for a review report applicable to all CAs. Instead, the review report should be a concise reflection of the CA review with the guidance provided in Section 3. The review report should include references to the CA, PA, and any related documentation. The conclusion of the review report should include the recommendation that the CA be accepted, accepted with conditions, or not accepted. Once submitted to the LFRG, no changes should be made to the final Review Report.

1.0 *Introduction*

This section provides a brief introduction on the purpose of the report, and includes a citation of the CA being reviewed and the guidance used to conduct the review. If the associated PA is a separate document, the PA citation should be included. There should also be a concise statement of the review process and review team findings, as well as an overview of the report contents.

2.0 *Summary of Facility Description and Interacting Source Terms*

This section provides sufficient background to readers of the review report who are unfamiliar with the disposal facility and potential contributing sources. This section provides a concise description of the overall geographic area addressed in the CA, of the LLW disposal facility and all potential sources that could interact with the disposal facility. This section should also identify those potential sources which were not considered in the CA and a concise explanation why they were excluded. The material in this section could be extracted from the CA, and may include material abstracted from the PA.

3.0 *Summary of CA Review*

This section provides an overview of the CA review. References to appendices that identify the members of the review team and consultants to the review team and the chronology of the review are appropriate. Documentation from the site that was prepared in response to requests for additional information by the review team should be discussed briefly, with references to the documentation itself. Issues identified during the course of the review and the resolutions should be documented in this section. Any appendices containing minutes or summaries of extended discussions of the review team can be referenced. The conclusions of the review should also be presented in this section.

4.0 *Technical Adequacy of the CA*

This section provides discussion of the following aspects of the CA:

- Summary of the method of analysis and the calculated results;
- Summary of options analyses, if required;
- Findings on CA completeness, thoroughness, technical supportability and quality of the conclusions of the CA;
- Major technical issues relating to the technical adequacy of the CA; and
- The basis for concluding that the CA is technically adequate and provides reasonable conclusions relative to the performance measures for environmental and public radiation protection in DOE O 5400.5.

5.0 *Consistency of CA*

This section documents the consistency of the CA with the Format and Content Guide for U.S. Department of Energy Low-Level Waste Disposal Facility Performance Assessments and Composite Analyses. There should be a discussion of how the guidance was interpreted for the CA, and a judgment on the consistency of approach with respect to the guidance. In the judgment of consistency, consideration of the interpretations made for existing laws, regulations, other DOE directives, DOE policy, and applicable agreements with regulatory agencies or affected states should be included. Conflicts with other competing regulatory matters and the approaches taken in the CA in addressing these conflicts, should be identified. The significance of any inconsistencies with respect to the acceptance of the CA should also be discussed.

6.0 *Unresolved Issues*

This section identifies any issues which were not satisfactorily or completely resolved in the CA review. The review of the CA is likely to identify issues to be addressed. Most of these issues were expected to be resolved in the course of the review by requests for additional information or discussions between the review team and the DOE site. Some issues, however, remain unresolved for lack of data or knowledge, or because of competing policies or regulatory directives. Some review team members may enter dissenting opinions on parts of the review. If so, these should be discussed in this section. Moreover, the significance of these unresolved issues on the review team's recommendation to the LFRG should be identified and discussed.

Because many unresolved issues may pertain to the uncertainties involved in the decision-making, the assumptions made, and the difficulty in agreeing or disagreeing with findings based on calculations far into the future, the CA maintenance program required by DOE M 435.1-1 can be used as an effective method for resolving these issues. The identification of studies to reduce uncertainty, analysis to justify assumptions, and the collection of data over time are all examples of conditions that should be considered for inclusion in the recommendation specifically as part of the facility's CA maintenance program. Recommendations for conditions on the CA maintenance program may allow the facility to continue to operate while the uncertainties are being studied.

7.0 *Recommendation of the Review Team*

The review team must recommend that the CA be accepted, accepted with conditions, or not accepted. The basis for the recommendation should be provided, including references to the relevant material in the review report.

If the review team recommends the CA be accepted, this means that all issues concerning the results of the CA are resolved. The documentation in the administrative record is complete and that a DAS should be issued.

If the review team recommends the CA be accepted with conditions, then the review team has identified issues that could not be resolved to their full satisfaction, but has identified further analysis, monitoring, or reporting that should be implemented in the corrective actions identified in the options analysis included in the CA and as conditions in the DAS. Conditions on the acceptance of the CA should be explicitly stated, with reference to the justifications for the conditions clearly identified in the materials reviewed and placed in the administrative record.

If the review team recommends the CA not be accepted, then the review team has identified major issues which could not be resolved through the development and implementation of any conditions on the operations, waste acceptance, monitoring, or reporting by the facility. It is expected that a "non-acceptance" would require additional rounds of review, therefore, the review report needs to clearly lay out the issues that cannot be resolved, the reasons they cannot be resolved, and comments that would provide assistance to the CA developers and the site/facility in providing the analysis or data that would allow for a finding of acceptance.

Appendices

Appendices should be used to reduce the review report's length and provide references to important information used in the CA review.

Appendix A lists the review team members, consultants and their qualifications.

Appendix B contains the review plan used for the CA review.

Appendix C includes a chronology of the CA review a list of all communications, meetings, and other events which occurred as part of the CA review.

Appendix D provides review team member comments and/or dissenting opinions that need to be reflected in the review report.

Appendix E lists written site/review team communications germane to the report conclusions.

Appendix F lists supporting documentation provided by the site for the review or used by the team. Material developed in response to questions from the review team should be included.

Appendix G review criteria matrix with review team comments.

Additional appendices may be added to the review report as appropriate.

2.9.5 Review Report Approval

The review team should review the draft report for adequacy and accuracy. The draft review report should be provided to the affected DOE field office management for a factual accuracy review. Site comments should be reviewed by the review team and incorporated in the final review report as appropriate. The final review report, together with a summary of the site review comments and the review team 's response to those comments should be submitted to the LFRG for review and approval.

2.10 Disposal Facility Compliance Evaluation

Upon completion of the review reports, the LFRG begins its deliberations on the PA and CA and whether to recommend approval by the cognizant Deputy Assistant Secretary. During these deliberations, the LFRG considers: the review report and the recommendations of the review team concerning the PA and/or CA; unresolved issues identified in the review report; issues which may have been identified after the report was submitted; and any additional information that may have been provided to the LFRG for consideration. If the LFRG concludes that the document is acceptable, the LFRG will prepare a compliance evaluation for the PA and/or CA.

If the PA and CA are submitted simultaneously, the LFRG can complete the review process and immediately follow-up with the development and submission of the DAS, if necessary. This effort would require the development of the compliance evaluation, pertinent supporting documentation and a draft DAS prior to formal submission to the cognizant Deputy Assistant Secretary.

If the PA and CA are not submitted at the same time, and the PA review is completed without the CA, then the following steps in development of a compliance evaluation and DAS should be modified appropriately. A suggested approach for the LFRG to consider if the PA and CA are submitted separately is in Section 4.4.2.

2.10.1 Issues Resolution

During the development of the review report, issues which were unresolved may become conditions for facility operation. The LFRG may decide that some or all of the issues should be resolved, or the recommendations of the review team modified, prior to the development of a compliance evaluation and/or DAS. If this is the action taken by the LFRG, the LFRG should not make any changes to the review report. Instead, the resolution or modification of conclusions concerning these issues should be thoroughly documented with issues papers, analyses, briefing minutes, and meeting minutes, and added to the administrative record for the PA/CA review. Resolution or modifications to these issues should be discussed in the compliance evaluation transmitted to the cognizant Deputy Assistant Secretary.

The LFRG should consider meeting with the Review Team members and site/facility personnel involved in the development of the PA and/or CA to assist in the resolution of unresolved issues that are identified in the Review Report.

2.10.2 LFRG Review of a PA Review Report

The LFRG thoroughly reviews the PA Review Report; assimilates the necessary information from the appendices and the administrative record; considers the PA, additional information, or issues discussed after the submittal of the review report, and addresses the following subjects:

1) DOE O 435.1/40CFR191 Compliance

The LFRG determines if the PA, as reviewed by the review team and discussed in the review report, provides a reasonable expectation that the requirements of DOE O 435.1/40 CFR 191 are met for the LLW/TRU disposal facility evaluated in the PA. The criterion for reasonable expectation is a "weight of evidence" determination that is based on the material included in the PA, supplemental documentation, and the review report.

2) Conditions of Acceptance

The recommendation of the review team that the PA be accepted, accepted with conditions, or not accepted should be reviewed and discussed in consideration of any unresolved issues in the review report. The LFRG evaluates conditions identified by the review team. Each condition of acceptance identified by the review team should be justified in the review report. The LFRG should settle unresolved issues identified in the review report and document the resolutions. Should these resolutions lead to modifications of the conditions for acceptance identified by the review team, changes to the conditions for acceptance should be made and documented. The use of the PA maintenance program to reduce uncertainties should be examined carefully to ensure that the goals of those conditions, as proposed by the review team, are both useful and reasonable.

New issues identified following the PA review should be discussed. Conditions for acceptance of the PA should be developed, and the basis for the new conditions should be documented. The final conditions for acceptance of the PA should be agreed upon by the LFRG. These final conditions and the justification of these conditions by the review report or other information should be documented as part of the decision of the LFRG.

3) Acceptance of the PA

In addition to the PA, the basis for its acceptance should include:

- The review report and its presentation to the LFRG;
- The administrative record;
- Evaluations by the LFRG; and
- Conditions imposed on acceptance of the PA.

The LFRG should review this material and conclude whether the PA should be accepted and recommended for approval. Acceptance of the PA and associated documentation means the

LLW/TRU disposal facility can be expected to operate under specified conditions with a reasonable expectation that the requirements of DOE O 435.1/40 CFR 191 will be met. [Approval of the PA and associated documentation also means the LLW/TRU disposal facility should be issued a DAS or the existing DAS be revised (if appropriate for a PA/CA revision), provided that a recommendation for approval is also made following the review of the CA (See Section 2.9.6)].

2.10.3 PA Compliance Evaluation Development

The findings of the LFRG should be documented in a compliance evaluation to be submitted to the cognizant Deputy Assistant Secretary for approval. If the LFRG does not recommend approval of the PA, then the recommended steps to be taken by the DOE site to gain acceptance and approval should be documented and submitted to the cognizant Deputy Assistant Secretary for transmittal to the field office manager.

If the LFRG recommends approval of the PA, a compliance evaluation documenting its approval should be prepared by the LFRG and submitted to the cognizant Deputy Assistant Secretary.

Essential elements of the compliance evaluation include:

- a summary of the findings on the subjects described in Section 2.9.2;
- conditions on the PA maintenance program;
- conditions on disposal operations;
- conditions on waste acceptance and receipt;
- conditions on monitoring;
- conditions on recordkeeping; and
- other pertinent information needed to maintain reasonable expectation that the performance objectives of DOE O and M 435.1/40 CFR 191 will be met.

The compliance evaluation should include a DAS with the proposed conditions for the facility to meet if the DAS is approved with conditions.

2.10.4 LFRG Review of a CA Review Report

The LFRG thoroughly reviews the CA review report; assimilates the necessary information from the appendices and the administrative record; considers the CA, including issues discussed after the submittal of the review report; and addresses the following subjects:

1) Conclusions Concerning Performance Measures

The LFRG will make two determinations about the CA based on the review report conclusions.

First, the LFRG will determine whether the CA provides a reasonable expectation that disposal facility operation is unlikely to result in long-term compliance problems. Second, the LFRG will determine whether the CA provides for appropriate management alternatives and corrective actions in the event that potential problems are identified. "Appropriate management alternatives and corrective actions" must yield a reasonable expectation that current LLW activities will not result in the need for future corrective or remedial actions.

Corrective actions are to be identified for LLW disposal facilities and other contributing sources which exceed the constraining performance measure. The corrective actions must provide a reasonable expectation that the constraining performance measure will not be exceeded in the future. The corrective actions should provide a reasonable first line of defense. Examples of corrective actions that should be proposed are:

- refining the analysis to reduce conservatism;
- limiting receipt of certain wastes until further information is collected;
- evaluating remedial measures on interacting source terms; and
- evaluating alternative land use plans.

Additional discussion of CA corrective actions can be found in the Format and Content Guide for U.S. Department of Energy Low-Level Waste Disposal Facility Performance Assessments and Composite Analyses.

The LFRG determination is based on the material presented in the CA, review report, and supplemental information developed for the review. The recommendation on acceptance of the CA should be supported by the review report and conditions placed on such a recommendation.

2) Conditions of Acceptance

The review team may recommend that the CA, be accepted, accepted with conditions, or not accepted. Review and discussion of the recommendation should consider unresolved issues in the review report and any other issues or information identified following the CA review. The LFRG will either concur with any conditions recommended by the review team or modify the recommendations based on other issues or information. If the LFRG elects to modify the recommendations of the review team, the justification for any modifications should be documented. The LFRG is to settle any unresolved issues identified in the review report and document the resolutions. If these resolutions lead to modifications of the conditions for acceptance identified by the review team, changes to the conditions for acceptance must be made and documented. New issues not identified by the review report that were identified following the CA review are to be discussed. Any conditions needed to address the issues for acceptance of the CA must be developed and the basis for the new conditions documented.

The final conditions for acceptance of the CA are to be agreed upon by the LFRG. These final conditions and the justification of these conditions by the review report or other information

must be documented as part of the decision of the LFRG.

3) Acceptance of the CA

The CA, review report, administrative record, evaluations by the LFRG, and any conditions for acceptance of the CA form the basis for accepting the CA. The LFRG should review this material and conclude whether the CA should be accepted and recommended for approval. Acceptance of the CA means the LLW disposal facility can be expected to operate under the specified conditions without the constraining dose limits being exceeded. If the CA (and the corresponding PA) is approved, a DAS may be issued for the facility (See Section 2.9.6).

2.10.5 CA Compliance Evaluation Development

The findings of the LFRG are documented in a compliance evaluation to be submitted to the cognizant Deputy Assistant Secretary for approval. In some cases, the LFRG may not accept the CA and not recommend approval of the CA. If so, the recommended steps to be taken by the DOE site to gain acceptance and approval should be documented and submitted to the cognizant Deputy Assistant Secretary for transmittal to the field office manager.

If the LFRG accepts the CA and recommends its approval by DOE, a Compliance Evaluation documenting approval of the CA will be prepared by the LFRG and submitted to the cognizant Deputy Assistant Secretary.

Essential elements of the compliance evaluation include:

- a summary of the findings on the subjects described in Section 2.9.4;
- conditions for acceptance of the CA; and
- other pertinent information needed to assure appropriate planning for continued protection of the public from radioactive material disposed in the facility.

The compliance evaluation may include a new or revised DAS with appropriate proposed conditions for approval by the cognizant Deputy Assistant Secretary.

2.10.6 Development of Disposal Authorization Statement

The LFRG develops or revises a draft DAS that authorizes the operation (or continued operation) of the LLW/TRU disposal facility evaluated in the PA and CA. The statement is based on the results of the PA and CA reviews as documented in the compliance evaluations, and specifies the conditions under which the LFRG would permit the operation to continue. The assistance of the review team leader should be solicited if necessary for developing the DAS.

References to the PA, CA, and other procedures and facility-specific documents should be included to ensure operational controls are clearly identified. Deadlines for submittal of information or data, and specific measures of performance should be identified for clarity.

Section 4 provides additional guidance on preparation of DAS.

2.10.7 Compliance Evaluation/Disposal Authorization Statement Approval

The compliance evaluations and DAS (original or revised) undergo a thorough internal (LFRG) review for adequacy and accuracy, both during preparation and prior to final transmittal. The LFRG completes the final compliance evaluations and draft DAS, and transmits them to the cognizant Deputy Assistant Secretary for final approval and signature. The LFRG also transmits any documentation such as the Review Report and documentation of resolution of issues that will assist the Deputy Assistance Secretary's understanding of the compliance evaluations and DAS. The cognizant Deputy Assistant Secretary should then take the appropriate action on the approval package in accordance with his management responsibilities. Failure to satisfy conditions on acceptance of the PA could lead to rejection or withdrawal of the DAS for the subject facility and/or shut down of the facility.

Additional details on approval of compliance evaluations and DAS are presented in Section 4.

2.11 Review Closeout

2.11.1 Review Feedback

The LFRG PA and CA review for a site includes an opportunity for evaluation and feedback by review team members, the staff responsible for the site/facility being reviewed, the LFRG, and other DOE organizations (e.g., EM; Office of Health, Safety, and Security (HS); field offices) involved with or affected by the review. If requested by the site/facility being reviewed, a meeting between the LFRG, review team members, and site personnel should be convened to provide for an understanding of the results of the review and the conditions recommended in the DAS.

2.11.2 Final Administrative Record

During the PA and/or CA review process, the Review Team Leader assembles the administrative record. Following approval of the DAS, if required, by the cognizant Deputy Assistant Secretary, the statement should be placed in the administrative record, and the review considered closed.

The administrative records for all PA and CA reviews will be stored and maintained in a central location. The LFRG Chair will identify the location for the headquarters files and the affected sites will be responsible for maintaining appropriate original records not held by headquarters and copies of originals relevant to their facility/facilities that are held by headquarters.

If the LFRG decides to take additional actions with respect to the disposal facility, then documentation of these actions will be placed into the same administrative record. When another substantive review of a PA and/or CA for the same disposal facility is conducted, for example, during a PA maintenance cycle, then the LFRG should use the same administrative record. The administrative record then becomes a comprehensive record of disposal authorization decisions through all or remaining operations at the facility, similar to a docket file

for a facility licensed by the Nuclear Regulatory Commission (NRC).

2.11.3 Conditions Tracking

The LFRG is responsible for ensuring that completion of actions or adherence with conditions specified in the Disposal Authorization Statement are tracked and a status provided to the cognizant Deputy Assistant Secretary, if requested. Completion of other commitments or actions of the site and/or LFRG related to the PA/CA review, but not specified in the Disposal Authorization Statement (e.g., commitment to update LFRG guidance), should also be tracked by the LFRG.

3. TECHNICAL REVIEW CRITERIA

The framework and technical review criteria for review teams to evaluate LLW disposal facility PAs (Section 3.1), TRU disposal facility PAs (Section 3.2), and disposal facility CAs (Section 3.3) are contained in this section.

PAs and CAs are technical studies that are prepared with considerable engineering and professional judgment. As a result, they contain arguments and discussions that often lead to results or conclusions that are uncertain. The review team must include these perspectives when reaching conclusions on the review of PAs and CAs. A key objective of the technical review of a PA or CA is to verify incorporation of and appropriate support for:

- relevant and important technical discussions;
- analyses and methodologies; and
- supporting data and information.

It is also important that this material include articulation of nuances of technical and engineering judgment.

The following sections include technical review criteria for PAs and CAs. In many cases, the criteria are followed by sub-criteria that describe the minimum information expected or other guidance on how each of the criteria can be measured. These criteria are to be used as guidance in the reviews of the PAs and CAs by the review team and for preparing the review reports discussed in Section 2.8.

The technical criteria presented in this Section have been formulated through prior PA/CA reviews. They provide benchmarks to be addressed in the review of PAs and CAs and provide direction to ensure the review satisfies its objectives. In the conduct of a specific review, modifications to these criteria or additional criteria may be required for determining the acceptability of site-specific information. Review teams must document the changes and additions to these criteria in the review report for specific PA/CA reviews. It's important that review teams have access to previous review reports on the site if they are available. It is also important for review team members to have access to review reports from other sites from a "Lessons Learned" perspective. These review reports are available at the LFRG Homepage.

3.1 LLW Disposal Facility PA Review Criteria

The review team must make the following fundamental conclusions if a PA is to be accepted:

- The PA is complete.
- The PA is thorough and technically supported.
- The PA conclusions are valid and acceptable.

Each of these conclusions can be made using the criteria presented in the following subsections. The criteria are intended to provide guidance and should be addressed in the review commensurate with the importance of each criterion to the performance of the site and disposal facility, and to the results and conclusions of a PA for evaluating LLW disposal pursuant to DOE O 435.1. The criteria provide a thorough listing of topics to be addressed in the course of the review and present the basis for any requests for additional information concerning a disposal facility or the PA. In addition to the review criteria, review teams should consider using the "Format and Content Guide for U.S DOE LLW Disposal Facility PAs and CAs".

The review criteria are separated into topical areas that correspond to areas of expertise that are needed to adequately review a PA/CA. These areas can be modified as required for a particular PA review circumstance.

3.1.1. Facility/Site Characteristics

3.1.1.1 PA presents information on the site geography, land use plans, meteorology, ecology, geology, seismology, volcanology, surface water and groundwater hydrology, geochemistry, geologic resources, and water resources sufficient to support the design of the facility.

3.1.1.2 PA presents information on the facility design features the waste disposal configuration operational and protection (e.g., flood protection, inadvertent intrusion barrier) features for the facility that affect long-term stability and design/engineering features of the

operational and closure covers at a level sufficient to support the analysis presented in the PA.

3.1.1.3 PA identifies Federal, state, and local statutes or regulations or agreements that impact site engineering, facility design, facility operations, and the relationship and/or impact of the results of the PA on site engineering, facility design, or facility operations because of these factors.

3.1.1.4 PA identifies procedures and facility related documentation that may impact site engineering, facility design, or facility operations and the relationship and/or impact of the results of the PA on the documents and site engineering, facility design, or facility operations.

3.1.1.5 PA identifies and justifies key assumptions included in the analysis that are used to model and evaluate the performance of the disposal facility. The assumptions of the PA related to the waste, site, and facility design and operations which are critical to the conclusions of the performance assessment are supported.

3.1.1.6 PA includes any necessary limitations on facility design or operations that are required to meet the performance objectives. The conclusions of the PA are applied to the facility design and operations. The resulting design constraints and limitations on operations can be reasonably accomplished at the disposal facility.

3.1.2 Radioactive Sources/Release Mechanism

3.1.2.1 The PA presents an estimate of the radionuclide inventory in the waste disposed and forecasted to be disposed at the facility which is quantified and technically supported by records, data, studies and evaluations. The PA should include a thorough analysis of waste disposal records with sufficient documentation to ensure that all of the radionuclides disposed and anticipated to be present in forecast wastes are evaluated. Radionuclides screened from the PA or having no inventory limit should be clearly identified, and the bases for screening and exclusion should be fully documented and defensible (for example, NCRP screening criteria). The technical bases for estimates of the radionuclide concentrations for past and future waste disposal should be described and documented.

3.1.2.2 The physical and chemical characteristics of the disposed waste that affect the release should be described including presence or absence and degradation of containers, the characteristics of the waste form, waste treatments that affect contaminant release, and potential interactions of chemical or hazardous constituents. The expected effects of waste form and container degradation should be included. The assessments of the physical and chemical characteristics of the waste form should be documented, and supported by laboratory or field studies. Any assumptions concerning release mechanisms should be specified.

3.1.3 Performance Objectives/Measures

3.1.3.1 PA identifies the performance measures used in the PA; justifies those performance measures as site-specific applications of the performance objectives and requirements; and presents valid conclusions that the PA meets the performance objectives of DOE O 435.1 identified below:

3.1.3.2 The all pathways performance objective of 25 mrem/year effective dose equivalent is met over the performance period of 1000 years after closure for all radionuclides disposed of in the disposal facility.

3.1.3.3 The air pathways performance objective of 10 mrem/year effective dose equivalent is met over the performance period of 1000 years after closure for post-September 1988 radionuclides disposed of in the disposal facility.

3.1.3.4 The radon performance objective of an average flux of 20 pCi/m^2/sec at the disposal surface or 0.5 pCi/L in air at the point of compliance is met over the performance period of 1,000 years after closure for all radionuclides disposed of in the disposal facility.

3.1.3.5 The groundwater resource performance measures for all radionuclides to be disposed of in the disposal facility are met over the performance period of 1,000 years after closure at the prescribed point of compliance. Impacts to the water resource protection should be assessed using the following hierarchical approach:

- First, the disposal site must comply with any applicable State or local law, regulation, or other legally applicable requirement.
- Second, the disposal site should comply with any formal agreement applicable to water resource protection that is made with appropriate State or local officials.
- Third, if neither of the above conditions applies, the site should select assumptions for use in the PA based on criteria established in the site groundwater protection management program and any formal land-use plans.
- If none of the above applies, the site may select assumptions for use in the PA for the protection of water resources that are consistent with the use of water as a drinking water source.

In terms of protecting the groundwater as a resource, assuming some volume averaging based on projected use may be appropriate. Applying the performance measure at an assumed wellhead mixed with a reasonable volume of groundwater based on site-specific assumptions regarding groundwater use is appropriate, provided the assumption of mixing is consistent with State or local laws, regulations, or agreements. The point of compliance for groundwater protection may consider institutional controls.

3.1.3.6 The inadvertent intruder performance measures of 100 mrem/year effective dose equivalent for chronic exposure and 500 mrem effective dose equivalent for acute exposure (regional social customs and well drilling, excavation, and construction practices should be considered) are met within the disposal facility over the performance period after the end of active institutional controls.

3.1.3.7 The PA shall include a determination that projected releases of radionuclides to the environment shall be maintained as low as reasonably achievable (ALARA). The goal of the ALARA process is attainment of the lowest practical release level after taking into account social, technical, economic, and public policy considerations.

3.1.4 Point of Assessment

3.1.4.1 PA identifies the point of assessment for each performance objective and measure, and justifies the selection of each point of assessment considering current and future land use and institutional controls.

3.1.4.2 The point of assessment for all-pathways, the air pathway excluding radon, and groundwater resource protection shall correspond to the point of highest projected dose or concentration beyond a 100 meter buffer zone surrounding the disposed waste. A larger or smaller buffer zone may be used if adequate justification (e.g., land use) is provided.

3.1.4.3 The default point of assessment for the performance measure for radon exposure that is based on a limit on the average flux of radon of 20 $pCi/m^2/sec$ at the ground surface is the ground surface over the disposal unit.

3.1.4.4 The default point of assessment for the alternative performance measure for radon exposure that is based on a limit on air concentration of radioactive material of 0.5 pCi/L is 100 m from the edge of the disposal unit.

3.1.5 Conceptual Model

3.1.5.1 PA provides a clear description of the conceptual model of the hydrogeological setting of the disposal facility. The PA accounts for all relevant processes for the release of radionuclides from the waste materials for environmental transport. The processes analyzed are justified by reference to relevant studies, available data, or supporting analyses in the PA.

3.1.5.2 The conceptual model incorporates alternative interpretations of the composite processes that control the transport of radionuclides at the disposal site.

3.1.5.3 The conceptual model is a reasonable interpretation of the existing geochemical geologic, meteorologic, hydrologic, and monitoring data for the site and disposal facility. Monitoring data can be used to test the validity of the conceptual model.

3.1.5.4 The conceptual model includes evaluation of institutional controls, design and engineered features of the facility and closure plans or reasonable assumptions for facility closure. Credits for the performance of engineered features and site closure included in the conceptual model are based on data derived from field investigations, related investigations, or documented sources of information relevant to the site and disposal facility. Credits for engineered features include a reasonable representation of the degradation of the engineered features that is justified by supporting investigations and data.

3.1.5.5 The conceptual model includes assessment of natural processes that could affect the long-term stability of a disposal facility (e.g., flooding, mass wasting, erosion, weathering) over the time period considered in the analysis. The assessments are justified based on referenced investigations and supporting analysis.

3.1.6 Mathematical Models

3.1.6.1 The analytical and numerical models used for the PA are reasonable representations of the conceptual model(s). There is sufficient documentation and verification of the

analytical and numerical models to provide reasonable confidence in the model results. The complexity of the mathematical models selected is commensurate with the available site data.

3.1.6.2 The input data used in the analytical and numerical models are described and are traceable to sources derived from field data from the site, laboratory data interpreted for field applications, and referenced literature sources which are applicable to the site. Assumptions which are used to formulate input data are justified and have a defensible technical basis.

3.1.6.3 The computational steps in the implementation of analytical and numerical models are clearly described and traceable.

3.1.6.4 Intermediate calculations are performed and results are presented that demonstrate, by comparison to site data or related investigations, the calculations used in the PA are representative of disposal site and facility behavior for important mechanisms represented in the mathematical models.

3.1.6.5 The analytical and numerical models are tested, by comparison to benchmarked analytical calculations or results of other well-established models and demonstrate that the results are consistent with the conceptual model and available site data. The models are evaluated for defensibility and are reasonable representations of the disposal site and facility performance by comparison to available site data, related technical investigations, or referenced documentation or literature.

3.1.6.6 The initial conditions, the boundary conditions, and the upscaling (i.e., normalization to field scale) of parameter data are applicable to the disposal facility and the expected range of changes in the physical and hydrologic properties of the site over 1,000 years.

3.1.7 Exposure Pathways and Dose Analysis

3.1.7.1 PA provides a complete description of the important exposure pathways and scenarios for the specific disposal facility that are used in the evaluation of the potential doses to the hypothetical, individual member of the public and inadvertent intruder consistent with site-specific environmental conditions and local and regional practices. The dose analysis is conducted for realistic and/or accepted scenarios for the setting of the facility and surrounding areas that represent the long-term performance of the LLW disposal facility. The exposure pathways and scenarios selected for detailed analysis are justified as representative.

3.1.7.2 Exposure pathways from the transport of contamination in groundwater and surface water that may be considered include potential exposures from the ingestion of contaminated water, the use of contaminated water for drinking, for irrigation and livestock watering, and the biotic uptake and transport of contamination from groundwater and surface water. The ingestion of dairy products, livestock, fish, crops, and soil, the inhalation of resuspended particles, and external exposure should be considered. Representations of groundwater well performance (e.g., construction,

diameter, yield, depth of penetration, screen length) are reasonable reflections of regional practices and are justified.

3.1.7.3 If radiation dose is used as a measure of groundwater resource protection, the exposure scenarios consider the ingestion of water (at 2 liters per day or an alternative rate, if a justification is included) at the point of assessment, which represents the location of maximum exposure from a well constructed and developed using current practices typical for the local area.

3.1.7.4 Exposure scenarios from the transport of contamination in air that may be considered include residential and gardening activities which include the direct inhalation of volatile and nonvolatile radionuclides, external exposure, ingestion of crops, soil, livestock, dairy products, and inhalation of re-suspended particles

3.1.7.5 The inadvertent intruder analysis considers the natural and man-made processes that impact the possible exposure to an intruder and calculates the dose using acceptable methodologies and parameters. Exposure pathways from inadvertent intrusion into the waste disposal units identify the chronic (no more than one year) and acute exposure pathways for each of the exposure scenarios considered. The exposure pathways include all relevant ingestion, external exposure, and inhalation pathways for each exposure scenario. [Direct ingestion of contaminated groundwater and exposures to radon should not be considered for inadvertent intrusion, because they are considered separately.]

3.1.7.6 The inadvertent intruder analysis specifies the reductions in concentrations of radioactive material from mixing with uncontaminated material or the transport of radionuclides from the disposed waste mass, and justifies the parameters used in the analysis with site data, supporting analysis or referenced information.

3.1.7.7 The inadvertent intruder analysis accounts for naturally occurring processes (e.g., erosion, precipitation, flooding) and the degradation of engineered barriers in the calculation of results.

3.1.7.8 The inadvertent intruder analysis calculates the maximum dose from disposed waste during the period from the end of active institutional controls to 1,000 years after site closure using the recommendations of ICRP-30 (1979) and DOE approved dose conversion factors.

3.1.7.9 Acute exposure scenarios for inadvertent intrusion consider direct intrusion into the disposal site and exhumation of accessible waste material. Relevant scenarios that may be considered include discovery, residential construction, and well drilling that incorporate external exposure, inhalation of resuspended particles, and ingestion of particles. The scenarios used shall be justified.

3.1.7.10 Chronic exposure scenarios for inadvertent intrusion consider direct intrusion into the disposal site and exhumation of accessible waste material for a period of up to one year.

Relevant scenarios that may be considered include residential use and post-construction, and post drilling agricultural use that incorporate the ingestion of foodstuffs, ingestion of soil, external exposure, and inhalation of re-suspended particles. The scenarios used shall be justified.

3.1.7.11 The dose analysis considers the exposure pathways and transfer factors between media and calculates the maximum dose using acceptable methodologies and parameters. Parameters used in the analysis are justified with supporting data or references.

3.1.7.12 The dose analysis specifies the consumption of radioactively contaminated materials for the exposure pathways evaluated, the inhalation rates of contaminated materials, and the external exposure rates and conditions to radioactive materials. These parameters are justified using references to the literature or site-specific investigations.

3.1.8 Sensitivity and Uncertainty

3.1.8.1 The PA includes sensitivity and uncertainty analysis at a sufficient level of detail to increase confidence in model results.

3.1.8.2 Acceptable methods of sensitivity analysis are used to identify and rank sensitivity parameters at a sufficient level of detail to use the results to screen future data needs or evaluate data sufficiency. Efforts are made to apply sensitivity analysis across all components of complex models to fully represent model variance. Variations analyzed in the uncertainty analysis that are important to the conclusions are justified as reasonable for the site and facility using data or related field investigations.

3.1.8.3 The results of the sensitivity and uncertainty analyses are used to assess model uncertainty and the effects of uncertainty on interpretations of model results. The analyses are based on currently accepted methodologies (probabilistic and deterministic) used in modeling studies. The results of the analysis are used to test confidence in the assumptions and conclusions of the PA.

3.1.8.4 Estimates of the uncertainty in disposed and forecast waste inventory should be described with the methods used to quantify uncertainty, including decay corrections.

3.1.8.5 The maximum projected dose, flux, or radionuclide concentration and time of occurrence is presented in the PA to provide for understanding of the natural system being modeled and the behavior of the model.

3.1.9 Results Integration

3.1.9.1 The calculated results presented in the PA are consistent with the site characteristics, the waste characteristics, and the conceptual model of the facility. The demonstration of consistency is supported by available site monitoring data and supporting field investigations. The results of the analyses for transport of radionuclides and the inadvertent intrusion into the disposal facility, and the sensitivity and uncertainty of the calculated results are comprehensive representations of the existing knowledge of the

site and the disposal facility design and operations.

3.1.9.2 Any inventory limits are developed from reasonable projections of waste to be disposed and analyses that consider the physical and chemical characteristics of the wastes if those characteristics affect the release and transport of the radionuclides.

3.1.9.3 The conclusions of the PA address and incorporate any constraints included in any Federal, state, and local statutes or regulations or agreements that impact the site design, facility design, or facility operations. The conclusions also address and incorporate any procedural or site documentation changes or constraints due to the results of the facility PA. Reasonable assurance exists that these constraints and impacts are appropriately addressed in the PA.

3.1.9.4 The PA integrates the results of the analysis, the sensitivity and uncertainty analysis, the comparisons with the performance measures, WAC, operating procedures, and applicable laws, regulations, policies and agreements to formulate conclusions.

3.1.9.5 The PA conclusions incorporate the findings of the calculated results for the all pathways analysis, air pathway analysis, groundwater resource protection analysis, inadvertent intruder analysis, and sensitivity and uncertainty analysis. The results are interpreted and integrated to formulate conclusions which are supported by the results and the uncertainties in the results. The conclusions are consistent with the uncertainty of the results.

3.1.9.6 The analysis, results, and conclusions of the PA provide both a reasonable representation of the disposal facility's long-term performance and a reasonable expectation that the disposal facility will remain in compliance with DOE O 435.1.

3.1.9.7 The maximum projected impacts during the 1000 year compliance period after facility closure at the point of compliance is used in the analysis for evaluating disposal of LLW and establishing WAC for future disposal.

3.1.10 Quality Assurance

3.1.10.1 The PA discusses quality assurance measures applied to the preparation of the analysis and its documentation (e.g., software quality assurance). The PA included appendices or references to published documents and/or data that provide a basis for the discussions and analysis in the PA.

3.2 PA Review Criteria for Transuranic Waste

The following sections specify the criteria to be used by a review team in evaluating whether the technical documentation provided by a site that plans to dispose of transuranic waste subject to the requirements of DOE M 435.1-1 is adequate. The documentation addresses compliance with the disposal requirements of 40 CFR 191 as well as DOE's expectation for a composite analysis as required by DOE M 435.1-1. These criteria reflect the expectations that DOE, as the implementing agency, has for meeting the 40 CFR 191 requirements.

The site documentation submitted to comply with requirements of DOE M 435.1-1 is to demonstrate that the disposal of transuranic waste:

- Complies with 40 CFR 191.13, Containment Requirements.
- Complies with 40 CFR 191.14, Assurance Requirements.
- Complies with 40 CFR 191.15, Individual Protection Requirements.
- Complies with 40 CFR 191.16 or 191.24, Ground Water Protection Requirements.

This process for TRU waste disposal parallels the process developed for DOE low-level waste disposal facilities and requires that the transuranic waste disposal system be included in a composite analysis in addition to complying with the requirements of 40 CFR 191. The composite analysis is a DOE requirement, separate from the performance assessment. Its purpose is to assess possible impacts from multiple radioactive sources, including the transuranic waste disposal system, on long-term compliance with DOE environmental and public radiation protection requirements contained in DOE Order 5400.5, *Radiation Protection of the Public and the Environment*. The composite analysis is not required for determining compliance with the 40 CFR 191 environmental standards, but it is an expected part of the analyses that the Department of Energy considers when determining compliance with DOE O 435.1.

A performance assessment is prepared as the technical analysis which demonstrates that the above requirements are met. These assessments:

- Identify the processes and events that might affect the disposal system;
- Examine the effects of these processes and events on the performance of the disposal system;
- Estimate the impacts from the release of radionuclides, considering the uncertainties caused by all significant processes and events; and
- Demonstrate compliance with 40 CFR 191.14, Subpart B, including the assurance requirements.

Because performance assessments project disposal system performance over long periods of time using complex analytical and numerical models, and expert judgment, substantial uncertainties will be encountered. Performance assessments do not lead to absolute or verifiable results or conclusions. Evaluation of the adequacy of the performance assessments is based on reasonable expectation of meeting the regulatory requirements as established by a review team, comprising personnel with a high level of technical knowledge in the areas of science that are important to the performance assessment.

The following sections include review criteria for review of performance assessments of transuranic waste disposal systems. In many cases, the review criteria are followed by sub-criteria that describe the minimum information expected or other guidance on how each of the criteria can be evaluated. These criteria are to be used as guidance in the reviews of the performance assessments by the review team, and for preparing the review reports discussed in Section 2.8.

The technical criteria presented in this chapter have been formulated with combined consideration of the 40 CFR 191 regulations, the August 1999 guidance developed by EH (see Appendix G), performance assessment reviews of low-level waste disposal facilities and of the WIPP facility. They provide benchmarks to be addressed in the review of performance assessments and provide direction to ensure the review satisfies its objectives. In the conduct of a specific review, modifications to these criteria or additional criteria may be required for determining the acceptability of site-specific information. Review teams must document the changes and additions to these criteria in the review report for specific performance assessment reviews.

The Review Team must determine if the following fundamental conclusions regarding the performance assessment and the other documentation provided to demonstrate compliance with the requirements are valid:

- The documentation and analyses are complete.
- The analyses are thorough and technically supported.
- The conclusions presented are valid and acceptable.

A finding that a technically acceptable analysis and presentation of information has been completed must be made for each of the four topics included in the following sections. These review findings should be based on review team assessment of the review criteria presented in the following subsections. These criteria provide guidance and should be addressed in the review commensurate with the importance of each criterion to the performance of the site and disposal system, and to the results and conclusions of a performance assessment for evaluating disposed transuranic waste.

The regulatory requirements of 40 CFR 191 issued in 1985 were revised in 1993. The requirements of the 1985 version are applicable to disposal between September 19, 1985, and January 19, 1994. The 1993 version (40 CFR 191.24) is applicable to disposal after January 19, 1994. DOE has decided that, as a matter of policy, facilities demonstrating compliance with the 1985 provisions should also include an analysis in the PA that compares performance to the 1993 groundwater requirements of 40 CFR 191.24, Disposal Standards. Such an analysis would not be for purposes of regulatory compliance, but only for information and comparison. To date, no DOE disposals other than the previously reviewed Greater Confinement Disposal Boreholes at NTS have been identified as being subject to the 1985 version of the rule. Thus, to shorten and simplify this manual, discussion of compliance with the 1985 version has been removed. If sites are identified which are subject to the 1985 version, they may either show compliance with the 1985 version using the guidance in Revision 1 of this manual, while including an analysis for purposes of comparison of the 1993 requirements, or choose to demonstrate compliance with the more stringent 1993 requirements.

3.2.1 Containment Requirements of 40 CFR 191.13

The 40 CFR Part 191 regulations include Section 191.13 that establishes containment requirements for disposal of transuranic waste. The containment requirements specify that there must be a reasonable expectation that the cumulative releases of radioactivity from disposed

transuranic waste will not exceed release limits for 10,000 years after disposal. The methodologies used to assess the containment requirement must be probabilistic.

The following acceptance criteria provide the basis for identifying questions to be addressed and requests for additional information concerning the disposal of transuranic waste or the performance assessment.

3.2.1.1 Criterion 1

The performance assessment identifies and aggregates inventories of radionuclides listed in 40 CFR 191, Appendix A, Table 1, Release Limits for Containment Requirements (see Appendix F of this manual for a copy of the regulation) that are present in the waste. A logical basis for how the radionuclides will be represented in the analysis is explained and justified.

1a. If probability distribution functions (PDFs) are used to represent the radionuclide inventories, the basis for assigning the distribution form (e.g., uniform, normal, triangular) is documented and justified. If single values (deterministic) are used to represent the inventories of radionuclides, the basis for selecting the values is described and justification is provided demonstrating that the single values are unlikely to underestimate the inventory and inventory uncertainty.

1b. The basis for estimating the radionuclide inventories of Table 1 is described and, to the extent practical, is based on a combination of past waste disposal records, a reasonable expectation of actual waste content that is based on knowledge of the processes that generated the waste, calculations, sampling data, technical studies, and reasonable projections of future waste disposals.

1c. The method of converting the radionuclides listed in 40 CFR 191, Table 1 to the required release limits is identified, justified, and has been performed correctly.

Discussion: The radionuclide inventories used for the containment analysis (Section 3.2.1), individual protection analysis (Section 3.2.3), and groundwater protection (Section 3.2.4) analysis should be consistent but are not necessarily the same inventories as specified in the requirements of 40 CFR 191. The radionuclides included in the containment requirements are the radionuclides specifically listed in Table 1 of Appendix A for 40 CFR 191.

The containment requirements are expressed as a complementary cumulative distribution function (CCDF) or 1 minus the cumulative distribution function (CDF). The CDF is an ascending curve derived by integration of the probability density function (PDF) where the PDF is the distribution of expected releases established from a performance assessment for a disposal system over 10,000 years. Figure 3-1 shows two examples of the integrated CCDF for the TRU Greater Confinement Disposal boreholes from the TRU performance assessment for the Area 5 Radioactive Waste Management Site (modified from Cochran et al. 2001[1]). The figure illustrates

[1] Cochran, J.R., Beyeler W., E., Brosseau D. A., Brush L. H., Brown T. J., Conrad S. H., Crowe, B.M., Davis P. A., Ehrhorn T., Feeney T., Fogleman W., Gallegos D. P., Haaker R., Kalinina E., Price L.L., Thomas D.P., and Sharon Worth S., *Compliance Assessment Document for the Transuranic Wastes in the Greater Confinement Disposal Boreholes at the Nevada Test Site, Volume 2: Performance Assessment, Version 1.1* (2001).

the features of the CCDF (examples shown with and without drill cuttings). The x-axis of Figure 3-1 is a measure of the total radioactivity released from a disposal system normalized to the release limits of Table 1 of Appendix A of 40 CFR 191. The y-axis is the probability of estimated releases. Regulatory acceptance is assumed if the mean CCDF or a family of CCDFs established from probabilistic cumulative releases from a TRU disposal site do not intersect (do remain to the left) of the stair-stepped curves defined by the probabilistic Environmental Protection Agency requirements for 40 CFR 191.13 (EPA acceptance boundary). The construction and interpretation of the CCDF plot of Figure 3-1 has been described in many publications; see Appendix B of the 1996 report by the National Research Council for an effective discussion of the development of a CCDF and its application to the CRs.[2]

[2] National Research Council. *The Waste Isolation Pilot Plant: A Potential Solution for the Disposal of Transuranic Waste*. National Academy Press. Washington D.C. (1996).

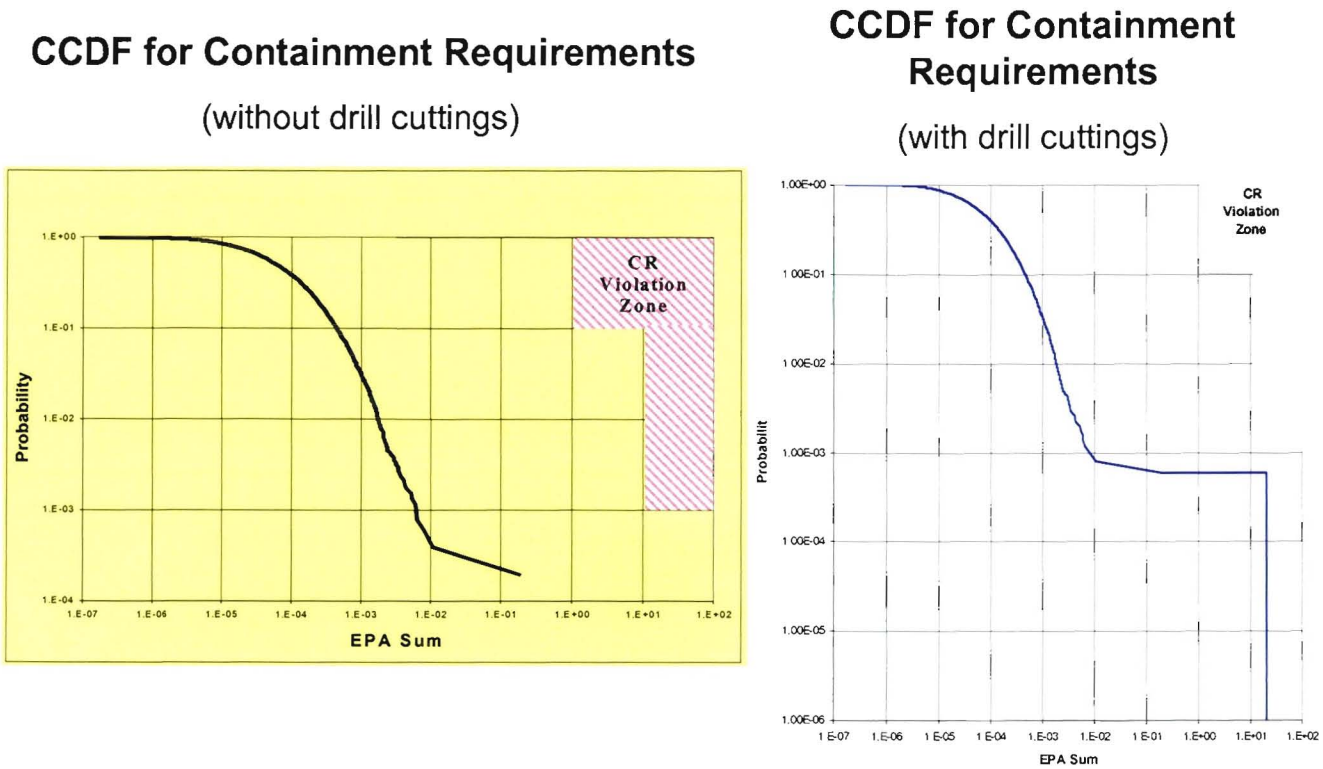


Figure 3-1. Two versions of the CCDF for the containment requirements for the TRU GCD boreholes at the Area 5 RWMS, Nevada Test Site (modified from Cochran et al. 2001). The left figure shows the CCDF without inclusion of drill cuttings and the right figure shows the CCDF with drill cuttings (modification added during the LFRG review of the GCD performance assessment). The figures show the important features of a CCDF diagram of the containment requirements and illustrate the sensitivity of the occurrence probability of the drilling scenario and the radiological releases associated with the scenario.

3.2.1.2 Criterion 2

The TRU performance assessment correctly applies the cumulative release limits of Appendix A Table 1 to the containment requirement of 40 CFR 191.13 (see Appendix F of this manual). The performance assessment supports a reasonable expectation of meeting the release limits for the 10,000 year time of compliance following sitedisposal.

2a. The performance assessment provides clear and comprehensive results of a probabilistic analysis that estimates the cumulative release of radionuclides in a technically adequate manner that accounts for all significant processes and events, to the extent practical.

2b. The performance assessment evaluates compliance against the release limits for 10,000 years following disposal through development and illustration of a complementary cumulative distribution function (CCDF) that does not exceed the release limits of 40 CFR 191.13. The CCDF is established from a sufficient number of model realizations to establish convergence and stability.

3.2.1.3 Criterion 3

The performance assessment identifies the "accessible environment" used for evaluating compliance with the containment requirement and justifies its selection (see Figures 3.2 and 3.3).

3a. The "accessible environment," is the atmosphere, land surface, surface waters and oceans, and the lithosphere outside of the "controlled area" where the "controlled area"

- has a boundary that is no more than 5 kilometers from the edge of the disposed waste,
- is within an area of no more than 100 square kilometers that is identified or will be identified by passive institutional controls, and
- includes the lithosphere underlying the above-defined surface location.

3b. The "accessible environment" is consistent with future land use plans. This means that the boundary at the earth's surface that defines the "controlled area" is coincident with or within the future site boundary of land that DOE intends to control (e.g., a boundary defined in accordance with its land use or long-term stewardship plan).

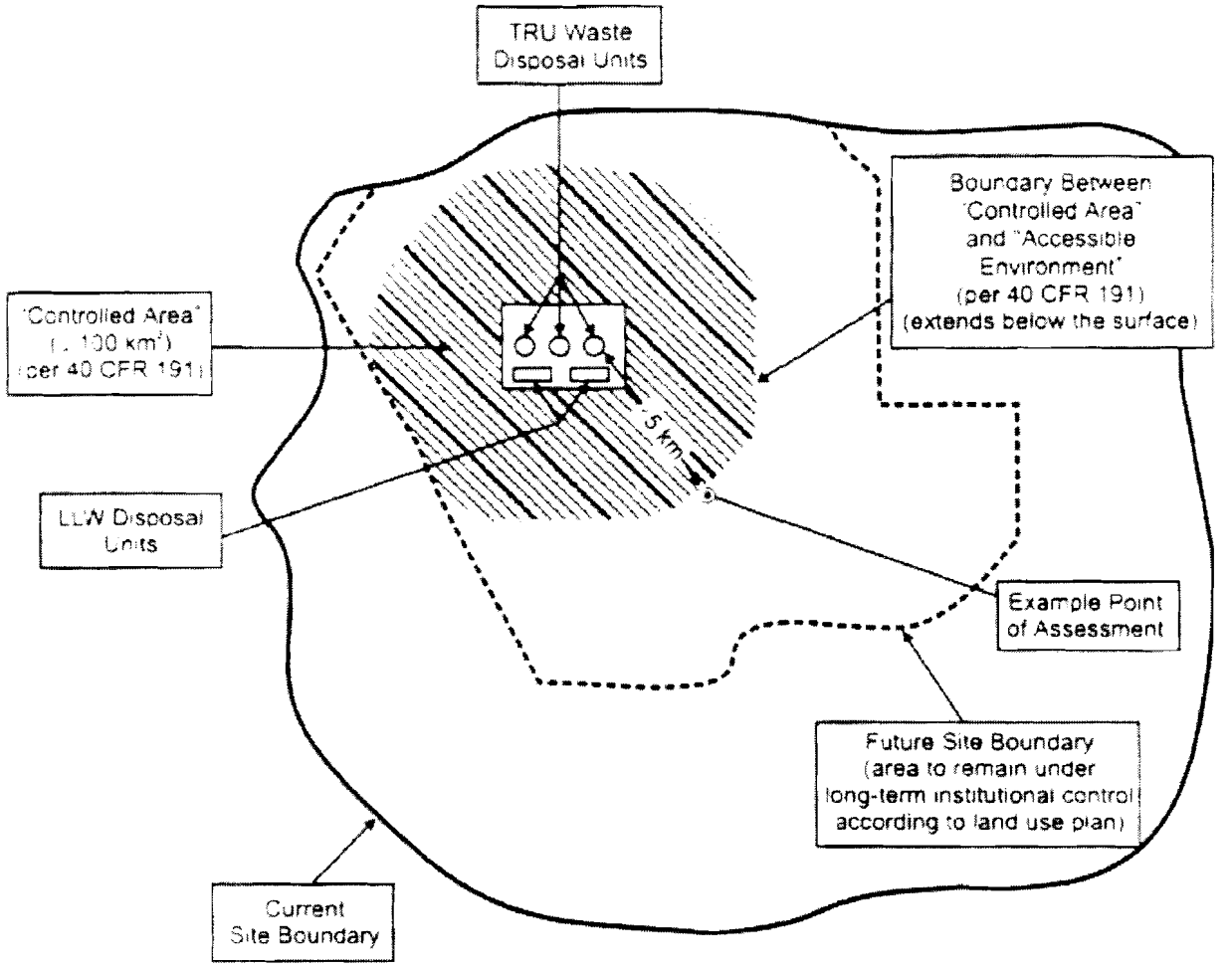


Figure 3.2. Illustration of the Location of the "Point of Assessment"

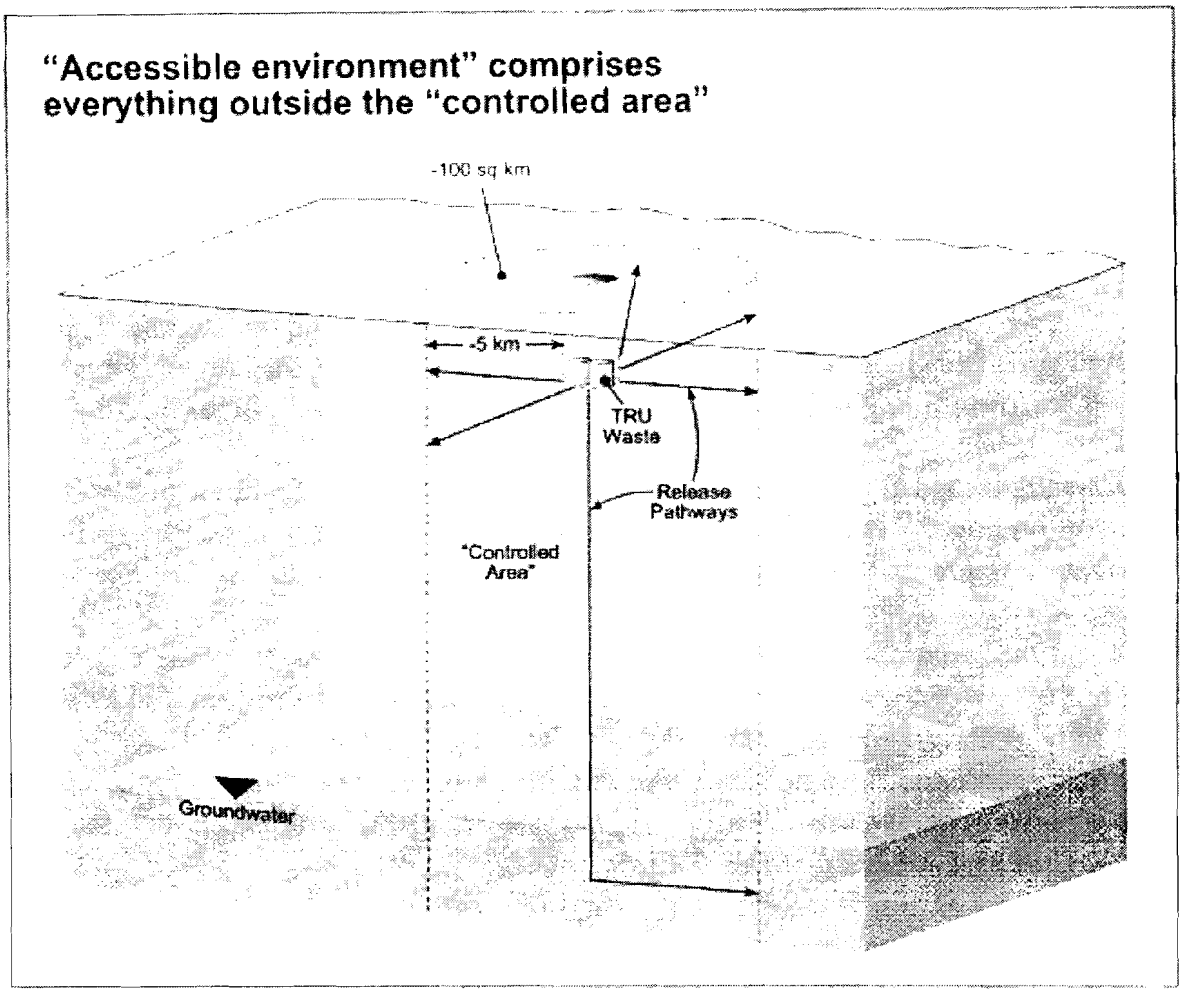


Figure 3.3. Confinement Evaluates Releases from the "Controlled Area" to the "Accessible Environment"

Discussion: The definition of the "accessible environment" requires some clarification. As defined in 40 CFR 191, the "controlled area" is the land surface as established above in 3b and the subsurface underlying that surface location. Whereas the "accessible environment" is generally perceived to be all locations outside the "controlled area," the land surface and surface water in "controlled area" are exceptions. The definition of "accessible environment" in 40 CFR 191, and the 1985 Supplementary Information (50 FR 38077) indicate that there is overlap between the "controlled area" and the "accessible environment" at the earth's surface. The regulation includes a list of five locations that comprise the "accessible environment" (1) The atmosphere; (2) land surfaces; (3) surface waters; (4) oceans; and (5) all of the lithosphere that is beyond the "controlled area." The Supplementary Information is clearer in that it only separates the "accessible environment" into two elements: "(1) The atmosphere, land surface, surface waters, and the oceans, wherever they are located; and (2) portions of the lithosphere – and the ground water within it – that are beyond the controlled area."

3.2.1.4 Criterion 4

The performance assessment accounts for all relevant mechanisms for releasing radionuclides from the waste and making them available for environmental transport, including diffusion, advection, and vapor phase transport. The mechanisms analyzed are justified by reference to relevant studies, available data, and supporting analyses.

4a. The performance assessment accounts for the physical and chemical characteristics of the waste and disposal system that affect release.

3.2.1.5 Criterion 5

The performance assessment presents information on the environment and the disposal system (hydrogeological setting) sufficient to support the analysis presented in the performance assessment and justifies the information by reference to relevant studies, available data, or supporting analyses.

5a. The transuranic waste disposal system is identified and described in terms of disposal units comprising the system, disposal unit design and closure, and nearby facilities. A justification is provided for what constitutes the disposal system.

5b. Sufficient information is provided in the performance assessment on the natural barrier system and environment to support the analysis, including, but not limited to, site geography, demography, current and future land use, meteorology, ecology, geology, seismology, volcanology, surface water and groundwater hydrology, geochemistry, geologic resources, water resources, and natural background radiation, and the performance assessment justifies the information.

5c. The performance assessment presents information on the engineered barrier system including, but not limited to, facility design features that address water infiltration, disposal unit cover integrity, and structural stability in detail sufficient to support the analysis, and justifies the information.

5d. The performance assessment presents information on the facility operational controls derived from facility-specific documentation (e.g., operating procedures, safety analysis reports, waste acceptance criteria) that impact the facility design, engineering, and facility operations and are significant in the performance assessment analysis.

3.2.1.6 Criterion 6

The performance assessment provides a clear and comprehensive description of the conceptual model of the site and processes associated with the release and transport of radionuclides from the waste materials to the accessible environment. The conceptual model is justified through reference to investigations, studies, data, evaluations, and supporting analyses that are representative of the site-specific conditions described.

6a. The conceptual model incorporates interpretations of available geochemical, geologic, meteorologic and hydrologic data, and the relevant mechanisms that have a significant

effect on the transport of radionuclides at the disposal site. The conceptual model includes natural processes that affect the transport of radionuclides (e.g., flooding, mass wasting, erosion, weathering) over the time period considered in the analysis, as justified based on referenced investigations and supporting analysis.

6b. The conceptual model for the source term, groundwater flow, and radionuclide transport includes parameters for unsaturated and saturated flow, total and effective porosity, hydraulic conductivity, water retention, relative permeability relationships, volumetric water content, retardation, and diffusion that are based on data, related investigations, and documented references relevant to the site and disposal system.

6c. The conceptual model incorporates interpretations of chemical, hydrologic, mechanical, and thermodynamic data and relevant mechanisms of the engineered features of the closed facility that have a significant effect on the release and transport of radionuclides. The conceptual model includes reasonable representations of the degradation of engineered features over the time period considered in the analysis. Performance attributed to engineered features and degradation of the performance of those features is justified.

6d. Natural features, events, and processes are identified. Categories of events or processes need not be considered if they have a low probability of occurrence using the criteria established in Appendix C to Part 191 (less than one chance in 10,000 of occurring over 10,000 years).

Discussion: Reviewers should consider whether scenarios have been inappropriately disaggregated into low-probability subscenarios.

6e. Assumptions incorporated into the conceptual model to account for transport mechanisms with sparse data or supporting analyses should be identified and justified as reasonable representations of expected site behavior over the time period considered in the analysis.

6f The conceptual model identifies and describes reasonable scenarios for the disturbed performance of the facility, which are consistent with the site- and facility-specific effects of the disposal system's environmental and design attributes, local or regional customs and construction practices (including well-drilling practices), and passive institutional controls.

Discussion: The EPA guidance on assessing impacts from an inadvertent intruder (included in 40 CFR 191, Appendix C) was developed for a geologic repository. Whereas the underlying philosophy in the guidance may be applied to any disposal system, some of the detailed guidance is not so generally applicable.[3]

Specifically, the Appendix C guidance occurrence and frequency of exploratory drilling and on the releases from a well-drilling event are not necessarily directly applicable to disposal systems that are being reviewed under this Manual (i.e., disposal systems other than geologic

[3] Guidance on interpretation of 40 CFR 191, Appendix C, to the Nevada Test Site Greater Confinement Disposal boreholes has been provided to the Nevada Operations Office by EII (August 1999).

repositories). The impacts of intruder analyses should be consistent with the following discussion. It is possible to hypothesize intruder scenarios so severe that no conceivable disposal system could be shown to meet the standards. That is, regardless of the site selection or design practices, it will always be possible to concoct an intrusion event that can be hypothesized to release radionuclides in excess of the release limits. Reasonable limits can be placed on the severity of the assumptions used to make the assessment. Each disposal system should be considered on its own, unique merits and characteristics and intrusion scenarios can be based on site-specific conditions, local practices, informed judgment, and other appropriate rationale. The most productive consideration of inadvertent intrusion in this regard concerns those realistic possibilities that may be usefully mitigated by disposal system location or design, or passive institutional controls.

3.2.1.7 Criterion 7

The performance assessment provides a clear and comprehensive description of the mathematical models used in the analysis, the basis for their selection, and the linkage from one model to the next. The mathematical models selected are justified and provide a reasonable representation of the technically important mechanisms identified in the conceptual model. The performance assessment provides a coherent presentation of the relevant descriptive information concerning the site, the disposal units, and waste characteristics that are reflected in the conceptual model, and the selection of the mathematical models used to represent them in the analysis.

7a. The complexity of the mathematical models selected is commensurate with the available site data and assumptions incorporated into the mathematical models are identified, justified, and consistent with the conceptual model. The calculations used in models and analytical solutions are clearly presented with sufficient detail to allow traceability and duplication of the results.

7b. Mathematical models incorporate equations and boundary conditions which reasonably represent the mathematical formulation of the conceptual models. Numerical models used in the assessments should provide stable solutions for a realistic range of model and parameter assumptions.

7c. Probability distributions of parameter inputs are documented, are consistent with the conceptual models, and are justified by reference to available data, relevant studies, and/or supporting analyses.

7d. Mathematical models selected are documented and verified and the verification presented or referenced.

3.2.1.8 Criterion 8

The performance assessment presents information demonstrating that the computer codes accurately implement the numerical models, (i.e., the computer codes are free of coding errors and produce stable solutions). The distributions and values that represent input parameters used in the computer codes are derived from field data from the site and facility, laboratory data

interpreted for field applications, referenced literature sources, or from technical judgment that is applicable to the site and facility.

8a. Important and highly sensitive parameters, numerical models and model assumptions are adequately justified using a combination of data, field investigations, and published resources that are relevant to the site and facility. If there are limited or no relevant data, the technical basis and justification for selection of parameter values and use of modeling assumptions is presented.

3.2.1.9 Criterion 9

The performance assessment presents technically defensible sensitivity and uncertainty analysis of parameters, scenarios and model results included in the performance assessment.

9a. The sensitivity analyses included in the performance assessment use acceptable methods for identifying sensitive parameters, models and scenarios that affect the uncertainty in the performance assessment. The sensitivity analysis methods should be traceable and documented.

9b. The uncertainty in model assumptions, parameter values, mathematical and conceptual models should be analyzed quantitatively or qualitatively to the extent necessary to justify a conclusion of reasonable expectation of meeting the requirements of 40 CFR 191.13. Methods used in the uncertainty analysis should be traceable and documented.

Discussion: Sensitivity and uncertainty analyses refer to evaluations of changes in model output with changes in input parameters and model and scenario assumptions. An assessment of acceptable uncertainty is site dependent and requires an assessment of the tradeoff between the cost and benefits of gathering data and the potential for uncertainty reduction. Generally, uncertainty analysis should be increasingly emphasized as predicted releases or doses approach regulatory limits. Sensitivity and uncertainty analyses are not specifically required in 40 CFR 191 but are implicit in establishing a reasonable expectation that the results adequately reflect the performance of a site.

3.2.1.10 Criterion 10

The performance assessment discusses the quality assurance measures applied to the preparation of the analysis and its documentation.

10a. Reference is made to the site- or facility-specific quality assurance program or program plan followed in development and execution of the performance assessment data collection and/or analysis, and specific references are included to quality assurance audits, surveillances, or monitoring of the performance assessment data collection and analysis activities, as appropriate.

10b. Information is provided that shows DOE O 414.4A, Quality Assurance, and DOE O 200.1, *Information Management Program*, were specifically followed in development and/or implementation of the software used in the analysis and its documentation. The information includes how the quality assurance measures discussed in DOE G 200.1a,

Software Engineering Methodology, or an equivalent has been used to develop and/or implement the software used in the analysis.

10c. Quality assurance measures are applied specifically to the data collection and analysis for the final iterations of the performance assessment that are included as the basis for demonstrating compliance with the performance measures or which are used for drawing conclusions about the performance of the facility.

3.2.2 Assurance Requirements of 40 CFR 191.14

The 40 CFR Part 191 regulations include section 191.14 that establishes assurance requirements for transuranic waste disposal. The assurance requirements were developed to provide increased confidence that the compliance requirements of Section 40 CFR 191.13 will be met over the long term. Whereas other requirements in 40 CFR 191 involve the preparation of a performance assessment to project movement of radionuclides through the environment, the assurance requirements relate more to the institutional, administrative, and engineering controls that are established to contribute to the safe isolation of the waste (defense in depth).

The following acceptance criteria provide the basis for developing a review plan and identifying questions to be addressed during the review.

3.2.2.1 Criterion 1

Site personnel have a plan, consistent with site usage and long-term land use and/or stewardship plans, for maintaining active and passive institutional control of the disposed transuranic waste. Active institutional controls are defined in 40 CFR 191 and include monitoring and maintenance performed to ensure that the transuranic waste disposal system performs as designed[4].

1a. Site documentation describes and justifies the active and passive institutional controls that will be employed (e.g., access control, monitoring, maintenance), and as appropriate, the location of the controls.

1b. Site documentation projects the time periods that active and passive institutional controls will be effective.

1c. Site documentation provides a rationale or justification for the time period for which active and passive institutional controls are projected to be effective.

3.2.2.2 Criterion 2

The performance assessment analysis is consistent with the projected effectiveness of the active institutional controls, but acceptable performance of the transuranic waste disposal system is not dependent on the controls continuing for longer than 100 years following closure of the site.

[4] DOE requirements and responsibilities under the Atomic Energy Act also require long-term institutional control. In accordance with the Atomic Energy Act and the DOE Organization Act, DOE responsibilities for controlling property and protecting the public and the environment continue regardless of analytical assumptions. See *The Long-Term Control of Property: Overview of requirements in Order DOE 5400.1 and 5400.5*, Information Brief EH-412-0014 1099 and DOE Policy 454.1 Use of Institutional Controls, April 9, 2003.

3.2.2.3 Criterion 3

The site has developed and documented a monitoring program that is capable of detecting substantial and detrimental changes in the expected disposal system performance.

3a. Monitoring program documentation identifies parameters that will be used as indicators of substantial and detrimental performance of the disposal system. Planned monitoring is consistent with expected performance.

Discussion: The monitoring program may comprise in situ field monitoring, controlled field experiments (e.g., closure cover studies), and laboratory studies. Under this criterion the review team should evaluate the media and parameters that site personnel have identified to include in the monitoring program.

3b. Monitoring program documentation includes a description of the monitored parameters, locations, and frequency of monitoring activities.

3c. Monitoring program includes a logical and technically acceptable rationale for the parameters selected, locations, and the monitoring frequencies.

3d. Even though this is not an explicit requirement of 40 CFR 191, for consistency with DOE M 435.1-1, the monitoring program describes and discusses action levels associated with monitoring.

Discussion: Generally, monitoring is performed to confirm that selected design features are not substantially deteriorating and that values of parameters significant to system performance are within ranges used in the performance assessment. The monitoring program should define the limits that will result in an action being taken and describe the action that will be taken. In some cases, the results of monitoring (field samples or laboratory results) may require a revision to the performance assessment. If there are plans to terminate the monitoring program, the criteria for making this decision should be identified and justified.

3e. The monitoring program is performed under the controls of a quality assurance program developed in accordance with applicable DOE regulations and orders.

3f. Conduct of the monitoring program will not jeopardize the isolation of the waste.

3.2.2.4 Criterion 4

Site personnel have identified markers, records and other specific passive institutional controls and described how they will be implemented.

Discussion: Passive institutional controls are defined in 40 CFR 191. However, as part of its focus on long-term stewardship, DOE is investing a substantial effort to develop further the means of providing institutional controls.

4a. The method of long-term marking of the site is described and justified including size and materials of construction of the markers, location and method of installation of the markers, and the information and languages to be included on the markers.

Discussion: The regulation requires that the site be marked by the most permanent markers practicable. The review team should determine if the plans for fabricating and installing the markers can be expected to provide long-term identification of the site. In addition, the review team should determine whether the message included on the marker includes ample warning that the site is dangerous.

4b. Information on the location, type of waste, radionuclide content, system design and any other pertinent information is recorded and is maintained in accordance with applicable DOE requirements.

Discussion: The review team should verify that records of the appropriate information about the waste and disposal site have been prepared and are being managed in accordance with current DOE requirements regarding records management and quality assurance. As of this writing, records management is addressed by DOE O 200.1 and quality assurance by DOE O 414.1A and 10 CFR 830.120.

4c. Documentation identifies local entities external to DOE that are to receive information about the transuranic waste disposal and the information they are to receive. The information to be conveyed provides sufficient description to identify the location, design, contents, and hazards associated with the disposed waste.

Discussion: The intent of the requirement is to ensure to the extent practical that information about the location and hazards associated with the disposed waste are available to future generations by placing information in the records of local governments in addition to the record keeping required by DOE. Appropriate means of transferring the information may include providing it to local land-use planning organizations and getting the information recorded in local records for the property.

3.2.2.5 Criterion 5

Engineered barriers and natural barriers intended to isolate waste from the accessible environment are used.

5a. Documentation describes the engineered and natural barriers that deter the movement of radionuclides from the disposal system. For the barriers described, their role in isolating waste from the accessible environment is discussed and justified, and as appropriate, consistent with analyses in the performance assessment.

Discussion: In regard to this subcriterion, natural barriers may include, but are not limited to, geologic features and characteristics (e.g., soil porosity and sorption properties), and hydrology. Engineered barriers may include, but are not limited to disposal unit design, closure design, waste form, and packaging.

3.2.2.6 Criterion 6

Transuranic waste disposal locations are not likely to be disturbed by mining or exploring for geologic resources.

6a. For the following geologic resources, documentation discusses whether they have been mined in the vicinity, whether there is a reasonable expectation of exploration for resources, or whether there are concentrations not widely available from other resources:

- minerals,
- petroleum and natural gas,
- valuable geologic formations,
- groundwater that is either irreplaceable because it supplies a substantial population and there is no reasonable alternative, or it is vital to preserving a unique and sensitive ecosystem.

Discussions should provide justification for claims that resources as discussed above are absent or otherwise not susceptible to future exploration or exploitation.

6b. If a resource is present or likely present such that it may be subject to exploration or exploitation, documentation identifies favorable site characteristics and justifies why these characteristics compensate for the likelihood of future human disturbance.

3.2.2.7 Criterion 7

Documentation provides a discussion of how the waste could be removed for a reasonable amount of time following disposal.

7a. The method of disposal is such that the waste and radionuclides can reasonably be expected to remain in their disposed location for an acceptable period of time.

7b. Documentation establishes that retrievability of the waste is feasible.

Discussion: Although there is no specific time specified in the regulation or review criteria, the review team should evaluate the time and rationale from the standpoint of the need to respond to new information about the safety of the disposal. The new information may be from the monitoring program (e.g., information from monitoring or studies that indicates an adverse change in performance), a change in information about the disposed waste, or a change in policy regarding disposal.

3.2.3 Individual Protection Requirements of 40 CFR 191.15

Individual Protection Requirements of 40 CFR 191 regulations include section 191.15 that establishes individual protection requirements for disposal of transuranic waste. The individual protection requirements specify that there must be a reasonable expectation that radioactive releases from the undisturbed performance of the transuranic waste disposal system will not cause doses to members of the public to exceed specified limits during the time of compliance. The term "undisturbed performance" means that the disposal system is not disrupted by human

intrusion or unlikely natural events. The individual protection methodologies may be either deterministic or probabilistic.

The following acceptance criteria provide the basis for identifying questions to be addressed and requests for additional information concerning disposal of the transuranic waste or the performance assessment.

3.2.3.1 Criterion 1

The performance assessment identifies the radionuclides in the waste and specifies the inventories of radionuclides potentially significant to the individual protection requirement. A logical basis for the selection and representation of the radionuclides in the analysis is explained and justified.

1a. If probability distribution functions (PDFs) are used to represent the radionuclide inventories, the basis for assigning the distribution form (e.g., uniform, normal, triangular) is documented and justified. If single values (deterministic) are used to represent the inventories of radionuclides, the basis for selecting the values is described and justification is provided demonstrating that how the single values are unlikely to underestimate the inventory and inventory uncertainties.

Discussion: The radionuclide inventories used for the containment analysis, individual protection analysis, and groundwater protection analysis should be consistent but are not necessarily the same inventories as specified in the requirements of 40 CFR 191. For the individual protection requirements, the inventory to be considered includes all radionuclides disposed of in the transuranic waste disposal system.

1b. All of the radionuclides disposed and anticipated to be present in wastes to be disposed of are evaluated in the performance assessment. The radionuclides should include the transuranic waste and co-located waste where co-located refers to low-level and/or mixed radioactive waste in the same disposal unit but not necessarily all disposal units in the disposal facility. Radionuclides screened from detailed analysis are identified, and the bases for these conclusions are supported and defensible.

1c. The basis for estimating the radionuclide inventories is described and, to the extent practical, is based on a combination of past waste disposal records, a reasonable expectation of actual waste content established from knowledge of the processes that generated the waste, calculations, sampling data, technical studies, and reasonable projections of future waste disposals.

1d. The performance assessment identifies radionuclides present in the waste that have been eliminated from detailed consideration in the individual protection requirement and describes and justifies the basis for their elimination.

3.2.3.2 Criterion 2

The performance assessment specifies that the dose limit is an annual committed effective dose of 15 mrem to any member of the public in the accessible environment

2a. The performance assessment provides a reasonable expectation that the undisturbed performance of the disposal system shall not cause the annual committed effective dose, received through all potential pathways from the disposal system, to any member of the public in the accessible environment, to exceed 15 millirems (150 microsieverts).

3.2.3.3 Criterion 3

The performance assessment analysis covers a sufficient time interval to support a reasonable expectation of meeting the specified limits for the time of compliance.

3a. The performance assessment evaluates compliance versus the dose limit for 10,000 years following disposal.

3b. Even though this is not an explicit requirement of 40 CFR 191, for consistency with DOE M 435.1-1, the performance assessment presents analyses for a sufficient period of time beyond the time of compliance and justifies the time period used. This extended analysis should support an assessment as to whether or not there is a reasonable expectation of compliance during and beyond the compliance interval. The main purpose of such an analysis is to demonstrate that reasonable variations of assumptions or parameter values are not likely to affect compliance by shifting releases that otherwise would be beyond the end of the compliance period back within the compliance period. The conditions (e.g., frequency of events) developed for the period of compliance should not be expanded for the longer assessment times.

3.2.3.4 Criterion 4

The performance assessment identifies the point of assessment and justifies its selection (see Figures 3.2 and 3.3). The point of assessment is the location at which compliance with the individual protection requirement is evaluated.

4a. The point of assessment is the point in the "accessible environment" where an individual is projected to receive the highest dose.

4b. The "accessible environment" is the atmosphere, land surface, surface waters and oceans and the lithosphere outside of the "controlled area" where the "controlled area"

- has a boundary that is no more than 5 kilometers from the edge of the disposed waste.
- is within an area of no more than 100 square kilometers that is identified or will be identified by passive institutional controls, and
- includes the lithosphere underlying the above-defined surface location. See discussion for Criterion 3 for in Section 3.2.1 and Figure 3.3.

4c. The point of assessment is in a location that is consistent with future land use plans. This means that the boundary at the earth's surface that defines the "controlled area" is coincident with or within the future site boundary that DOE intends to control (e.g., a

boundary defined in accordance with its land use or long-term stewardship plan). See related discussion in Section 3.2.1, Criterion 3.

Discussion: The definition of the "accessible environment" requires some clarification. As defined in 40 CFR 191, the "controlled area" is the land surface as established above in 4b and the subsurface underlying that surface location. Whereas the "accessible environment" is generally perceived to be all locations outside the "controlled area," the land surface and surface water in "controlled area" are exceptions. The definition of "accessible environment" in 40 CFR 191, and the 1985 Supplementary Information (50 FR 38077) indicate that there is overlap between the "controlled area" and the "accessible environment" at the earth's surface. The regulation includes a list of five locations that comprise the "accessible environment" (1) the atmosphere; (2) land surfaces; (3) surface waters; (4) oceans; and (5) all of the lithosphere that is beyond the "controlled area." The Supplementary Information is clearer in that it only breaks the "accessible environment" into two elements: "(1) The atmosphere, land surface, surface waters, and the oceans, wherever they are located; and (2) portions of the lithosphere – and the ground water within it – that are beyond the controlled area." Therefore, for purposes of individual protection analyses, an individual can reside at any surface location within or outside the "controlled area." However, because the definition of "accessible environment" excludes the subsurface of the "controlled area," including groundwater, analysis of the impact to an individual living at a surface location within the "controlled area" should not include use of groundwater from below the "controlled area." For an individual living at a surface location outside the "controlled area" use of groundwater is a valid assumption.

3.2.3.5 Criterion 5

The performance assessment accounts for all relevant mechanisms for releasing radionuclides from the waste and making them available for environmental transport, including diffusion, advection, and vapor phase transport. The mechanisms analyzed are justified by reference to relevant studies, available data, and supporting analyses.

5a. The performance assessment accounts for the physical and chemical characteristics of the waste and disposal system that affect release.

3.2.3.6 Criterion 6

The performance assessment presents information on the environment and the disposal system (hydrogeological setting) sufficient to support the analysis presented in the performance assessment and justifies the information by reference to relevant studies, available data, or supporting analyses.

6a. Sufficient information is provided in the performance assessment on the natural barrier system including, but not limited to, site geography, demography, current and future land use plans, meteorology, ecology, geology, seismology, volcanology, surface water and groundwater hydrology, geochemistry, geologic resources, water resources, and natural background radiation to support the analysis, and justifies the information.

6b. The performance assessment presents information on the engineered barrier system including, but not limited to, facility design features that address water infiltration,

disposal unit cover integrity, and structural stability in detail sufficient to support the analysis, and justifies the information.

6c. The performance assessment presents information on the facility operational controls derived from facility-specific documentation (e.g., operating procedures, safety analysis reports, waste acceptance criteria) that impact the facility design, engineering, and facility operations and are significant in the performance assessment analysis.

3.2.3.7 Criterion 7

The performance assessment provides a clear and comprehensive description of the conceptual model of the site and processes associated with the release and transport of radionuclides from the waste materials to the accessible environment. The conceptual model is justified through reference to investigations, studies, data, evaluations, and supporting analyses that are representative of the site-specific conditions described.

7a. The conceptual model incorporates interpretations of available geochemical, geologic, meteorologic and hydrologic data, and the relevant mechanisms that have a significant effect on the transport of radionuclides at the disposal site. The conceptual model includes natural processes that affect the transport of radionuclides (e.g., flooding, mass wasting, erosion, weathering) over the time period considered in the analysis, as justified based on referenced investigations and supporting analysis.

7b. The conceptual model for the source term, groundwater flow, and radionuclide transport includes parameters for unsaturated and saturated flow, total and effective porosity, hydraulic conductivity; water retention, relative permeability relationships; volumetric water content, retardation, and diffusion that are based on data, related investigations; and documented references relevant to the site and disposal system.

7c. The conceptual model incorporates interpretations of chemical; hydrologic; mechanical, and thermodynamic data and relevant mechanisms of the engineered features of the closed facility that have a significant effect on the release and transport of radionuclides. The conceptual model includes reasonable representations of the degradation of engineered features over the time period considered in the analysis. Performance attributed to engineered features and degradation of performance is justified.

7d. Natural features, events, and processes are identified. Categories of events or processes need not be considered if they have a low probability of occurrence using the criteria established in Appendix C to Part 191 (less than one chance in 10,000 of occurring over 10,000 years). The individual protection requirements are assessed for undisturbed performance and do not include the effects of human intrusion or the occurrence of unlikely natural events.

7e. Assumptions incorporated into the conceptual model to account for transport mechanisms lacking sufficient data or supporting analyses are identified and justified as reasonable representations of site behavior over the time period considered in the analysis.

3.2.3.8 Criterion 8

The performance assessment provides complete descriptions of the important exposure pathways and scenarios for the specific disposal system that are used in the evaluation of the potential doses to a hypothetical member of the public consistent with site-specific environmental conditions and local and regional practices. The exposure pathways and scenarios selected for detailed analysis are justified as reasonable representations which are unlikely to lead to underestimating doses for the long-term.

8a. The performance assessment includes consideration of exposure pathways from the transport of contamination in groundwater including potential exposures from the ingestion of contaminated groundwater; the use of contaminated groundwater for irrigation and livestock watering, and the biotic uptake and transport of contamination from groundwater and surface water. Potential exposure pathways from the transport of contamination in surface water include the above pathways plus the ingestion of contaminated fish.

8b. Exposure scenarios from the transport of contamination in water consider the use of groundwater and surface water consistent with local and regional practices. Exposure scenarios considered include drinking water, crop irrigation and livestock watering; the ingestion of dairy products, livestock, fish, crops, and soil, the inhalation of resuspended soil particles, and external exposure.

8c. The performance assessment includes consideration of exposure pathways from the transport of contamination in the atmosphere including potential exposure from immersion in air contaminated with volatile and nonvolatile radionuclides, deposition of volatile and nonvolatile radionuclides, and subsequent exposure from direct radiation, ingestion, and resuspension.

8d. Exposure scenarios from the transport of contamination in air consider residential and agricultural/gardening activities which include the direct inhalation of volatile and nonvolatile radionuclides, external exposure, ingestion of crops, soil, livestock, dairy products, and fish, and inhalation of resuspended soil particles.

8e. The dose analysis for exposures to radionuclides identifies the transfer coefficients between media and justifies the parameters used in the analysis with supporting data or references to literature.

8f For the pathways evaluated, the dose analysis specifies the consumption rates of radioactively contaminated materials, the inhalation rates of contaminated materials, and the external exposure rates and conditions for radioactive materials. These parameters are justified using references to literature or site-specific investigations.

8g. The performance assessment identifies and justifies the dose conversion factors and methodology used in the dose analysis.

Discussion: It is expected that the dose analysis for compliance with the 1993 version of the regulation will use current Federal government-approved dose methodology and dose coefficients[5] (dose conversion factors).

3.2.3.9 Criterion 9

The performance assessment provides a clear and comprehensive description of the mathematical models used in the analysis, the basis for their selection, and the linkage from one model to the next. The mathematical models selected are justified and provide a reasonable representation of the technically important mechanisms identified in the conceptual model. The performance assessment provides a coherent presentation of the relevant descriptive information concerning the site, the disposal units, and waste characteristics that are reflected in the conceptual model, and the selection of the mathematical models used to represent them in the analysis.

9a. The complexity of the mathematical models selected is commensurate with the available site data and assumptions incorporated into the mathematical models are identified, justified, and consistent with the conceptual model. The calculations used in models and analytical solutions are clearly presented with sufficient detail to allow traceability and duplication of the results.

9b. Mathematical models incorporate equations and boundary conditions which reasonably represent the mathematical formulation of the conceptual models. Numerical models used in the assessments should provide stable solutions for a realistic range of model and parameter assumptions.

9c. Probability distributions of parameter inputs, if used, are documented, are consistent with the conceptual models, and are justified by reference to available data, relevant studies, and/or supporting analyses.

9d. Deterministic analyses use parameter values that are reasonable representations which are unlikely to underestimate doses and are justified by reference to available data, relevant studies, and/or supporting analyses.

9e. Mathematical models selected are documented and verified and the verification presented or referenced.

3.2.3.10 Criterion 10

The performance assessment presents information demonstrating that the computer codes accurately implement the numerical models, (i.e., the computer codes are free of coding errors and produce stable solutions). The distributions and values that represent input parameters used in the computer codes are derived from field data from the site and facility, laboratory data

[5] DOE recommends the use of the dose factors in Federal Guidance Report #11 (EPA-520/1-88-020) and Federal Guidance Report #12 (EPA 402-R-93-081). Internal dose factors in DOE/EH-0071, July 1988 and external dose factors in DOE/EH-0070, July 1988, are equivalent to the Federal guidance reports and may also be used.

interpreted for field applications, referenced literature sources, or from technical judgment that is applicable to the site and facility.

10a. Important and highly sensitive parameters, numerical models and model assumptions are adequately justified using a combination of data, field investigations, and published resources that are relevant to the site and facility. If there are limited or no relevant data, the technical basis and justification for selection of parameter values and use of modeling assumptions is presented.

3.2.3.11 Criterion 11

The performance assessment presents technically defensible sensitivity and uncertainty analysis of parameters, scenarios and models results included in the performance assessment.

11a. The sensitivity analyses included in the performance assessment use acceptable methods for identifying sensitive parameters, models and scenarios that affect the uncertainty in the performance assessment. The sensitivity analysis methods should be traceable and documented.

11b. The uncertainty in the model assumptions, parameter values, mathematical and conceptual models should be analyzed quantitatively or qualitatively to the extent necessary to justify a conclusion of reasonable expectation of meeting the requirements of 40 CFR 191.15. Methods used in the uncertainty analysis should be traceable and documented.

Discussion: See the discussion of sensitivity and uncertainty analyses for Criterion 9 of the containment requirements.

3.2.3.12 Criterion 12

The performance assessment presents valid conclusions demonstrating the analysis of estimated doses to an individual meets the individual protection requirement of 40 CFR 191.15 for the period of compliance. These estimates can use either deterministic or probabilistic methodologies.

For deterministic analyses

12a. The performance assessment clearly presents the results of the individual protection analysis and the associated sensitivity and uncertainty of the dose estimates. Assumptions and parameters of the deterministic analysis should result in acceptable overestimates of the doses.

For probabilistic analyses

12b. The performance assessment uses PDFs for the key components of the model assumptions and parameters and properly capture the uncertainty of the dose estimates. Compliance should be based on the mean or the median distribution of the results, whichever is higher.

12c. The performance assessment results are based on a sufficient number of model realizations to provide confidence in the convergence and stability of the percentile values used to establish compliance.

For deterministic or probabilistic analyses

12d. The performance assessment includes results that allow realistic comparisons to the dose limits, and these results are incorporated into any necessary limitations on facility design, operating procedures, waste acceptance criteria, or closure plans.

12e. Even though this is not an explicit requirement of 40 CFR 191, for consistency with DOE M 435.1-1, the conclusions of the performance assessment address and incorporate constraints included in Federal, state, and local statutes, regulations or agreements that impact the site design, facility design, or facility operations. There is reasonable expectation that these constraints and impacts are appropriately addressed in the performance assessment.

3.2.3.13 Criterion 13

The performance assessment discusses the quality assurance measures applied to the preparation of the analysis and its documentation.

13a. Reference is made to the site- or facility- specific quality assurance program or program plan followed in development and execution of the performance assessment data collection and/or analysis, and specific references are included to quality assurance audits, surveillances, or monitoring of the performance assessment data collection and analysis activities, as appropriate.

13b. Information is provided that shows DOE O 414.4A, *Quality Assurance*, and DOE O 200.1, *Information Management Program*, were specifically followed in development and/or implementation of the software used in the analysis and its documentation. The information includes how the quality assurance measures discussed in DOE G 200.1-a, *Software Engineering Methodology*, or an equivalent has been used to develop and/or implement the software used in the analysis.

13c. Quality assurance measures are applied specifically to the data collection and analysis for the final iterations of the performance assessment that are included as the basis for demonstrating compliance with the performance measures or which are used for drawing conclusions about the performance of the facility.

3.2.4 Groundwater Protection Requirements of 40 CFR 191.16/24

The 40 CFR Part 191 regulations include a section that establishes groundwater protection requirements for disposal of transuranic waste. The groundwater protection requirements specify that there must be a reasonable expectation that radioactive releases from the undisturbed performance of the transuranic waste disposal system will not exceed specified concentration limits or cause doses to members of the public to exceed specified limits during the time of compliance. The term "undisturbed performance" means that the disposal system is not

disrupted by human intrusion or unlikely natural events. The groundwater protection methodologies may be either deterministic or probabilistic. For probabilistic analysis, compliance should be based on the mean or the median distribution of the results, whichever is higher.

The groundwater protection provisions of 40 CFR 191 issued in 1985 were revised in 1993. The requirements of the 1985 version (40 CFR 191.18) are applicable to disposal which occurred between September 19, 1985, and January 19, 1994. The 1993 version (40 CFR 191.24) is applicable to disposal which occurred after January 19, 1994. DOE has decided that, as a matter of policy, facilities demonstrating compliance with the 1985 provisions should also include an analysis in the PA that compares performance to the 1993 groundwater requirements of 40 CFR 191.24, Disposal Standards. Such an analysis would not be for purposes of regulatory compliance, but only for information and comparison. To date, no DOE disposals other than the previously reviewed Greater Confinement Disposal Boreholes at NTS have been identified as being subject to the 1985 version of the rule. Thus, to shorten and simplify this manual, discussion of compliance with the 1985 version has been removed. If sites are identified which are subject to the 1985 version, they may either show compliance with the 1985 version using the guidance in Revision 1 of this manual, while including an analysis for purposes of comparison of the 1993 requirements, or choose to demonstrate compliance with the more stringent 1993 groundwater requirements of 40 CFR 191.24, Disposal Standards.

The following acceptance criteria provide the basis for identifying questions to be addressed and requests for additional information concerning the disposal of transuranic waste.

3.2.4.1 Criterion 1

The performance assessment provides information and discussion to justify a determination of whether the groundwater that could be impacted by the disposal of transuranic waste is subject to the requirements of 40 CFR 191 and applicable state regulations.

1a. The performance assessment presents a determination and justification as to whether the groundwater in the accessible environment that is potentially impacted by the disposal of transuranic waste is an "underground source of drinking water" as defined in 40 CFR 191.22.

Discussion: If the performance assessment reports that the groundwater does not meet the definition of an "underground source of drinking water" and the review team concurs with the determination, no additional review related to this finding is necessary. If the groundwater is determined to be an "underground source of drinking water," then the following criteria should guide the balance of the review.

3.2.4.2 Criterion 2

Determine whether the disposal system is above or within a formation which is within one-quarter mile of an underground source of drinking water. If so, the ground water protection standards do not apply to as indicated at 40 CFR 191.24(a) (2).

3.2.4.3 Criterion 3

The performance assessment identifies the radionuclides in the waste and specifies the inventories of radionuclides potentially significant to the groundwater protection requirement. A logical basis for how the radionuclides will be represented in the analysis is explained and justified.

3a. If probability distribution functions (PDFs) are used to represent the radionuclide inventories, the basis for assigning the distribution form (e.g., uniform, normal, triangular) is documented and justified. If single values are used to represent the inventories of radionuclides, the basis for selecting the values is described and justification provided how the single values are unlikely to underestimate the inventory and inventory uncertainty.

Discussion: The radionuclide inventories used for the containment analysis, individual protection analysis, and groundwater protection analysis should be consistent but are not necessarily the same inventories as specified in the requirements of 40 CFR 191. For the groundwater protection analysis (for the 1993 version of the regulation), the radionuclide inventory includes any radioactivity in the groundwater regardless of source (including background radiation).

3b. All of the radionuclides disposed and anticipated to be present in wastes to be disposed of are evaluated in the performance assessment. Radionuclides screened from detailed analysis are identified, and the bases for these conclusions are supported and defensible.

3c. The basis for estimating the radionuclide inventories of are described and, to the extent practical, are based on a combination of past waste disposal records, a reasonable expectation of actual waste content that is based on knowledge of the processes that generated the waste, calculations, sampling data, technical studies, and reasonable projections of future waste disposals.

3.2.4.4 Criterion 4

The performance assessment clearly identifies and describes the basis for the performance measures that are used to evaluate compliance with the groundwater protection requirements of 40 CFR 191.24.

Discussion: The limits are specified in 40 CFR 141 as they existed on January 19, 1994 (see Appendix H). Modifications may be necessary to comply with applicable state regulations.

4a. Concentration limits are established for radium and gross alpha activity consistent with 40 CFR 141 (January 19, 1994).

4b. The concentration limits established above include all sources including the contribution from natural background.

4c. A dose limit is established for beta particle and photon activity consistent with 40 CFR 141 (January 19, 1994).

3.2.4.5 Criterion 5

The performance assessment analysis covers a sufficient time interval to support a reasonable expectation of meeting the concentration and dose limits for the time of compliance.

5a. The performance assessment evaluates compliance versus the concentration and dose limits for 10,000 years following disposal..

5b. Even though this is not an explicit requirement of 40 CFR 191, for consistency with DOE M 435.1-1, the performance assessment presents analyses for a sufficient period of time beyond the time of compliance and justifies the time period used. This extended analysis should support an assessment as to whether or not there is a reasonable expectation of compliance during and beyond the compliance period. The main purpose of such an analysis is to demonstrate that reasonable variations of assumptions or parameter values are not likely to affect compliance by shifting releases that otherwise would be beyond the end of the compliance period back within the compliance period. The conditions (e.g., frequency of events) developed for the period of compliance should not be expanded for the longer assessment times.

3.2.4.6 Criterion 6

The performance assessment identifies the point of assessment and justifies its selection (see Figure 3.2 and Figure 3.3). The point of assessment is the location at which compliance with the groundwater protection requirement is evaluated.

6a. The point of assessment is the point in the "accessible environment" where the projected radionuclide concentration in drinking water from an underground source of drinking water or the projected dose to an individual consuming such water is highest.

6b. The "accessible environment" is the atmosphere, land surface, surface waters and oceans, and the lithosphere outside of the "controlled area" where the "controlled area"

- has a boundary that is no more than 5 kilometers from the edge of the disposed waste,
- is an area of no more than 100 square kilometers that is identified or will be identified by passive institutional controls, and
- includes the lithosphere underlying the above-defined surface location.

6c. The point of assessment is in a location that is consistent with future land use plans. This means that the boundary at the earth's surface that defines the "controlled area" is coincident with or within the future site boundary that DOE intends to control (e.g., a boundary defined in accordance with its land use or long-term stewardship plan). See related discussion in Section 3.2.1, Criterion 3.

3.2.4.7 Criterion 7

The performance assessment accounts for all relevant mechanisms for releasing radionuclides from the waste and making them available for environmental transport, including diffusion, advection, and vapor phase transport. The mechanisms analyzed are justified by reference to relevant studies, available data, and supporting analyses.

7a. The performance assessment accounts for the physical and chemical characteristics of the waste and disposal system that affect release.

3.2.4.8 Criterion 8

The performance assessment presents information on the environment and the disposal units sufficient to support the analysis presented in the performance assessment and justifies the information by reference to relevant studies, available data, or supporting analyses.

8a. Sufficient information is provided in the performance assessment on the natural barrier system including, but not limited to, site geography, demography, current and future land use plans, meteorology, ecology, geology, seismology, volcanology, surface water and groundwater hydrology, geochemistry, geologic resources, water resources, and natural background radiation to support the analysis, and justifies the information.

8b. The performance assessment presents information on the engineered barrier system including, but not limited to, facility design features that address water infiltration, disposal unit cover integrity, and structural stability in detail sufficient to support the analysis, and justifies the information.

8c. The performance assessment presents information on the facility operational controls derived from facility-specific documentation (e.g., operating procedures, safety analysis reports, waste acceptance criteria) that impact the facility design, engineering, and facility operations and are significant in the performance assessment analysis.

3.2.4.9 Criterion 9

The performance assessment provides a clear and comprehensive description of the conceptual model of the site and processes associated with the release and transport of radionuclides from the waste materials to the accessible environment. The conceptual model is justified through reference to investigations, studies, data, evaluations, and supporting analyses that are representative of the site-specific conditions described.

9a. The conceptual model incorporates interpretations of available geochemical, geologic, meteorologic and hydrologic data, and the relevant mechanisms that have a significant effect on the transport of radionuclides at the disposal site. The conceptual model includes natural processes that affect the transport of radionuclides (e.g., flooding, mass wasting, erosion, weathering) over the time period considered in the analysis, as justified based on referenced investigations and supporting analysis.

9b. The conceptual model for the source term, groundwater flow, and radionuclide transport includes parameters for unsaturated and saturated flow, total and effective porosity, hydraulic conductivity, water retention, relative permeability relationships, volumetric water content, retardation, and diffusion that are based on data, related investigations, and documented references relevant to the site and disposal system.

9c. The conceptual model incorporates interpretations of chemical, hydrologic, mechanical, and thermodynamic data and relevant mechanisms of the engineered features of the closed facility that have a significant effect on the release and transport of radionuclides. The conceptual model includes reasonable representations of the degradation of engineered features over the time period considered in the analysis. Performance attributed to engineered features and degradation of performance are justified.

9d. Natural features, events, and processes are identified. Categories of event or processes need not be considered if they have a low probability of occurrence using the criteria established in Appendix C to Part 191 (less than one chance in 10,000 of occurring over 10,000 years).

9e. Assumptions incorporated into the conceptual model to account for transport mechanisms lacking sufficient data or supporting analyses are identified and justified as reasonable representations of site behavior over the time period considered in the analysis.

3.2.4.10 Criterion 10

The performance assessment provides a complete description of the groundwater exposure pathways and scenarios used in the evaluation of the potential doses to a hypothetical member of the public consistent with site-specific environmental conditions and local and regional practices. The exposure pathway and scenario are justified as reasonable representations which are unlikely to lead to underestimating doses for the long-term.

10a. The performance assessment includes an exposure pathway from the transport of contamination in groundwater including potential exposures from the ingestion of contaminated groundwater.

10b. Exposure scenario from the transport of contamination in water involves drinking water at a rate of 2 liters per day as specified in 40 CFR 141, January 19, 1994.

10c. The dose analysis for exposures to radionuclides identifies the transfer coefficients between media and justifies the parameters used in the analysis with supporting data or references to literature.

10d. The performance assessment identifies and justifies the dose conversion factors and methodology used in the dose analysis.

3.2.4.11 Criterion 11

The performance assessment provides a clear and comprehensive description of the mathematical models used in the analysis, the basis for their selection, and the linkage from one

model to the next. The mathematical models selected are justified and provide a reasonable representation of the technically important mechanisms identified in the conceptual model. The performance assessment provides a coherent presentation of the relevant descriptive information concerning the site, the disposal units, and waste characteristics that are reflected in the conceptual model, and the selection of the mathematical models used to represent them in the analysis.

11a. The complexity of the mathematical models selected is commensurate with the available site data and assumptions incorporated into the mathematical models are identified, justified, and consistent with the conceptual model. The calculations used in models and analytical solutions are clearly presented with sufficient detail to allow traceability and duplication of the results.

11b. Mathematical models incorporate equations and boundary conditions which reasonably represent the mathematical formulation of the conceptual models. Numerical models used in the assessments should provide stable solutions for a realistic range of model and parameter assumptions.

11c. Probability distributions of parameter inputs, if used, are documented, are consistent with the conceptual models, and are justified by reference to available data, relevant studies, and/or supporting analyses.

11d. Deterministic analyses use parameter values that are reasonable representations and are justified by reference to available data, relevant studies, and/or supporting analyses.

11e. Mathematical models selected are documented and verified and the verification presented or referenced.

3.2.4.12 Criterion 12

The performance assessment presents information demonstrating that the computer codes accurately implement the numerical models (i.e., the computer codes are free of coding errors and produce stable solutions). The distributions and values that represent input parameters used in the computer codes are derived from field data from the site and facility, laboratory data interpreted for field applications, referenced literature sources, or from technical judgment that is applicable to the site and facility.

12a. Important and highly sensitive parameters, numerical models and model assumptions are adequately justified using a combination of data, field investigations, and published resources that are relevant to the site and facility. If there are limited or no relevant data, the technical basis and justification for selection of parameter values and use of modeling assumptions is presented.

3.2.4.13 Criterion 13

The performance assessment presents a technically defensible sensitivity and uncertainty analysis of the parameters, models, and scenarios included in the performance assessment.

13a. The sensitivity analysis included in the performance assessment use acceptable methods for identifying sensitive parameters, models and scenarios that affect the uncertainty in the performance assessment. The sensitivity analysis methods should be traceable and documented.

13b. The uncertainty in model assumptions, parameter values, mathematical and conceptual models should be analyzed quantitatively or qualitatively to the extent necessary to justify a conclusion of reasonable expectation of meeting the requirements of 40 CFR 191.16/24. Methods used in the uncertainty analysis should be traceable and documented.

Discussion: See the discussion of sensitivity and uncertainty analyses for Criterion 9 of the containment requirements.

3.2.4.14 Criterion 14

The performance assessment presents valid conclusions that demonstrate that the groundwater protection requirement of 40 CFR 191.24 will be met for the period of compliance. These estimates can use either deterministic or probabilistic methodologies.

For deterministic Analyses

14a. The performance assessment clearly presents the results of the individual protection analysis and the sensitivity and uncertainty of the dose estimates. Assumptions and parameters of the deterministic analysis should result in acceptable overestimation of the doses.

For probabilistic analysis

14b. The performance assessment uses PDFs for the key components of the model assumption sand parameters and properly captures the uncertainty of the dose estimates. Compliance can be based on the mean or median distribution of the results, whichever is higher.

14c. The performance assessment results are based on a sufficient number of model realizations to provide confidence in the convergence and stability of the percentile values used to establish compliance.

For deterministic or probabilistic analyses

14d. The performance assessment includes results that allow realistic comparisons to the dose limits and these results are incorporated into any necessary limitations on facility design, operating procedures, waste acceptance criteria, or closure plans

14e. Even though this is not an explicit requirement of 40 CFR 191, for consistence with DOE M 435.1-1, the conclusions of the performance assessment address and incorporate constraints included in federal, state and local statutes, regulations, or agreements that impact the site design, facility design, or facility operations. There is reasonable expectation that these constraints and impacts are appropriately addressed in the performance assessment.

3.2.4.15 Criterion 15

The performance assessment discusses the quality assurance measures applied to the preparation of the analysis and its documentation.

15a. Reference is made to the site- or facility- specific quality assurance program or program plan followed in development and execution of the performance assessment data collection and/or analysis, and specific references are included to quality assurance audits, surveillances, or monitoring of the performance assessment data collection and analysis activities, as appropriate.

15b. Information is provided that shows DOE O 414.4A, *Quality Assurance*, and DOE O 200.1, *Information Management Program*, were specifically followed in development and/or implementation of the software used in the analysis and its documentation. The information includes how the quality assurance measures discussed in DOE G 200.1-a, *Software Engineering Methodology*, or an equivalent has been used to develop and/or implement the software used in the analysis.

15c. Quality assurance measures are applied specifically to the data collection and analysis for the final iterations of the performance assessment that are included as the basis for demonstrating compliance with the performance measures or which are used for drawing conclusions about the performance of the facility.

3.3 CA Review Criteria

3.3.1 Site and Facility Characteristics

3.3.1.1 The CA provides a coherent presentation of the relevant descriptive information concerning the disposal site, its location on the DOE site, and its proximity to other sources of radioactive material. The sources of radioactive material are described including relevant features that could influence radionuclide release and migration.

3.3.2. Radioactive Sources/Release Mechanism

3.3.2.1 The CA identifies all sources of radioactive material in the ground that could contribute to the potential future doses from the LLW disposal facility. Sources selected for the CA and the reasons for excluding any source are justified. Potential sources of radioactive material to be considered include wastes disposed of prior to 1988, other LLW disposal facilities, transuranic waste or alpha LLW disposal, buildings, tanks, cribs, spills, ditches, seepage basins, and leaks.

3.3.2.2 The CA identifies and quantifies all radionuclides present in the LLW disposal facility and all other contributing sources of radioactive material that could contribute significantly to the total potential dose. Inventory estimates included in the analysis are justified. The estimates of radionuclide species and inventories in the sources selected for consideration are derived from referenced documentation or data summaries presented in the CA and are based on existing records, process knowledge, or site

investigations (e.g., Remedial Investigations, Feasibility Studies). Any radionuclides that are screened from the analysis are identified and their exclusion justified as being insignificant contributors to the total dose estimated in the analysis.

3.3.2.3 The known physical and chemical characteristics of the radioactive materials considered in the CA, the site characteristics, and the effects of the Comprehensive Environmental Responses, Compensation, and Liability Act (CERCLA) actions prescribed in the Record of Decisions (RODs) or similar binding agreements such as those associated with Decontamination and Decommissioning (D&D), are included in the generation of the source terms and the transport of the radionuclides. Extrapolations are made and justified from known data to estimate radionuclides and inventories where clear information does not exist.

3.3.2.4 Source terms and flow and transport models in the CA are commensurate with the available data consistent with the PA, incorporate the important characteristics identified in the PA, and provide outputs consistent with the PA.

3.3.3 Performance Measures

3.3.3.1 The CA presents an assessment using the time of 1,000 years for exposures to hypothetical members of the public with all disposal facilities closed, D&D completed, and operations at the DOE site terminated. The assessment establishes a realistic case for comparison with the dose constraint (30 mrem/yr) and dose limit (100 mrem/yr).

3.3.4 Point of Assessment

3.3.4.1 The point of assessment is the publicly accessible point of maximum impact reasonably expected for future members of the public for the time period of assessment. The point of assessment is justified and is supported by land use plans or reasonable assumptions that are justified.

3.3.4.2 Changes in the point of assessment as a function of time are justified.

3.3.5 Assumptions

3.3.5.1 Assumptions incorporated into the analysis, including those related to the radionuclides to be considered, the inventories of radionuclides, the source term evaluation and the transport of radionuclides, are identified, justified, and consistent with the conceptual model of site behavior presented in the PA conducted on the LLW disposal facility.

3.3.5.2 The CA identifies results, objectives, constraints, or milestones of other DOE programs, Federal, state, or local statutes, or agreements (e.g., D&D programs, Formerly Utilized Sites Remedial Action Program (FUSRAP), CERCLA RODs) that may impact the analysis or conclusions of the CA.

3.3.6 Modeling

3.3.6.1 The CA presents a reasonable methodology for estimating the transport of radionuclides to the point of assessment from all sources based on and consistent with the available site data

3.3.6.2 Analytical and numerical models selected are documented and verified either in referenced publications or in the appendices of the CA.

3.3.6.3 Any analytical and numerical models used in the CA for analyzing the transport of radionuclides to the point of assessment are appropriate for the LLW disposal facility and all other contributing sources. The models used in the CA provide calculated results that are representative of the results calculated in the PA for similar wastes in similar disposal facilities.

3.3.6.4 Credits for CERCLA/Resource Conservation & Recovery Act of 1976 (RCRA) actions or other actions (e.g., D&D, tank closures) are represented in the conceptual models used in the CA, and are justified by supporting or referenced documentation.

3.3.6.5 The input data to the models are based on field data from the site, laboratory data interpreted for field applications, referenced literature sources which are applicable to the site, or related analyses performed for the PA. Any assumptions used to formulate input data are justified and have a defensible technical basis.

3.3.6.6 Intermediate calculations are performed, and the results are presented to demonstrate the CA calculations are representative of the site and are consistent with results presented in the PA for similar situations.

3.3.6.7 The conceptual model used for the CA is consistent with the representation of the conceptual model used in the PA, and includes the major mechanisms affecting the transport of radionuclides at the DOE site. The components of the conceptual model for the CA are reasonably represented in the analysis of the LLW disposal facility and other contributing sources.

3.3.7 Exposure Pathways and Dose Analysis

3.3.7.1 The CA provides a complete discussion of all important exposure pathways for the evaluation of potential doses to a hypothetical, individual member of the public at the point of exposure for any time during the period of assessment. The exposure pathways identified in the CA should be consistent with the exposure pathways in the PA. The exposure pathways considered in the CA include only those pathways that are related to the exposure of individual members of the public at the point of assessment and are justified.

3.3.7.2 The dose analysis performed for the CA is consistent with that performed for the PA for similar exposure pathways and similar exposure scenarios.

3.3.8 Sensitivity/Uncertainty

3.3.8.1 The sensitivity and uncertainty analysis considers factors such as alternative land use plans, CERCLA/RCRA actions or other actions (e.g., D&D, tank closures), radionuclide inventories, site and facility characteristics, and transport parameters to provide reasonable estimates of potential doses at the point of assessment for the period of the assessment. The maximum projected dose over the period of the assessment (at least 1,000 years) is presented at the point of assessment.

3.3.8.2 The calculated results and the sensitivity or uncertainty analysis results are used to evaluate meeting the dose constraint of 30 mrem/year and the dose limit of 100 mrem/year at the point of assessment over the period of assessment.

3.3.9 ALARA & Options Analysis

3.3.9.1 For analyses that exceed the dose constraint of 30 mrem/year but are less than the dose limit of 100 mrem/year, an options analysis is provided which identifies alternatives that could be conducted to reduce the dose to less than the dose constraint. The options analysis, using the ALARA process, considers alternatives which are technically feasible and demonstrated to be effective in reducing doses to the public at the point of assessment over the period of the assessment.

3.3.9.2 For analyses that exceed the dose limit of 100 mrem/year, an options analysis, using the ALARA process, is provided which identifies alternatives that should be conducted to reduce the dose to less than the limit. The options analysis, using the ALARA process, considers alternatives which are technically feasible and demonstrated to be effective in reducing doses to the public at the point of assessment over the period of the assessment.

3.3.9.3 The ALARA process uses a cost-benefit analysis based on the cost of dose-reduction in accordance with DOE O 5400.5.

3.3.10 Results Integration

3.3.10.1 The results of the analysis for the source terms and transport of radionuclides, dose analysis, available site monitoring data, supporting field investigations, sensitivity or uncertainty analysis and options analysis are reasonable representations of the existing knowledge of the site, disposal facility, and contributing sources.

3.3.10.2 The analysis, results, and conclusions of the CA provide a reasonable representation of the disposal facility and other contributing sources for determining the appropriate actions to be taken for the protection of public health and environment. The analysis and results of the CA are consistent with comparable results of the PA and provide a defensible and complete basis for an acceptable decision by DOE.

3.3.10.3 The conclusions of the CA address and incorporate any constraints resulting from other DOE programs or from any Federal, state, and local statutes or regulations or

agreements that would influence the calculated results or the options analysis.

3.3.10.4 Implementation of the conclusions from the options analysis can be reasonably accomplished at the disposal facility or the other contributing sources.

3.3.11 QA

3.3.11.1 The CA discusses QA measures applied to the preparation of the analysis and its documentation. The CA includes appendices or references to published documents that provide a basis for the discussions in the CA.

4. DISPOSAL AUTHORIZATION STATEMENT

4.1 Introduction

4.1.1 Purpose

The DOE radioactive waste management order, DOE O 435.1, imposes a requirement that operating disposal facilities for LLW and for mixed LLW obtain a Disposal Authorization Statement. Facilities managed under the CERCLA may use an approved ROD as their Disposal Authorization Statement, provided that the requirements of DOE O 435.1 have been incorporated and met, as appropriate. Prior DOE policy and guidance also imposed similar conditions on operation of existing disposal facilities. This chapter describes the purpose, content, review and approval process, and references relevant to Disposal Authorization Statement and CERCLA RODs used as Disposal Authorization Statements. For the remainder of this section, when the term LLW is used, it is intended to include mixed LLW as well.

4.1.2 Disposal Authorization Requirement

The requirement that a Disposal Authorization Statement be obtained for LLW disposal was introduced in the DOE Implementation Plan prepared in response to Defense Nuclear Facilities Safety Board (DNFSB) Recommendation 94-2. It states that the PA and CA will be the basis for preparation of a Disposal Authorization Statement (p. VII-3). The requirement in DOE M 435.1-1 also specifies that three additional facility documents be considered in approving a Disposal Authorization Statement: (1) the PA and CA Maintenance Plan; (2) Preliminary Closure Plan; and (3) the Preliminary Monitoring Plan. A key element of the Implementation Plan was to allow substitution of the CERCLA process for satisfaction of the substantive requirements of DOE radioactive waste management orders. DOE O 435.1 incorporates this alternative approach for facilities managed under the provisions of CERCLA.

4.1.3 Applicability

The requirement to obtain a Disposal Authorization Statement is applicable to facilities that dispose of LLW and mixed LLW. Only facilities that are in operation or will operate in the future are subject to the Disposal Authorization Statement requirement. Disposal facilities that are planned must obtain a Disposal Authorization Statement prior to construction. If the PA/CA are revised, the Disposal Authorization Statement must be reviewed for possible revision.

If the facility is now used or is to be used for on-site disposal of LLW generated by on-site environmental restoration under CERCLA, the ROD (see section 4.1.5 for details) for the CERCLA clean-up can serve as the Disposal Authorization Statement.

4.1.4 Responsibility

The principal organizations that are responsible for designing, constructing, operating, and closing LLW disposal facilities are EM & NNSA. Some of the EM/NNSA disposal facilities are intended primarily for on-site disposal of LLW from CERCLA activities, while the other disposal facilities are expected to receive waste from a much broader range of generators.

The Cognizant Deputy Assistant Secretaries for EM/NNSA are responsible for approving Disposal Authorization Statement for each CERCLA and non-CERCLA facility at sites under their direction. The ROD for a CERCLA facility may be designated by the cognizant Deputy Assistant Secretary to additionally serve as the Disposal Authorization Statement, provided that the requirements of DOE O 435.1 have been incorporated and met, as appropriate.

4.1.5 Adaptation of Disposal Authorization for CERCLA Facilities

The DOE/NNSA recognizes that although their activities are subject to the provisions of the Atomic Energy Act of 1954, as amended, some DOE/NNSA LLW disposal activities must also comply with the provisions of CERCLA. The DOE/NNSA has sought to reduce duplication of effort that could result from independently satisfying the requirements of both of these statutes and their implementing regulations and other requirements. The potential duplication of effort is addressed in DOE M 435.1-1 by allowing for demonstration of compliance with the substantive requirements of DOE Os using CERCLA activities. DOE M 435.1-1 specifies that a crosswalk identifying the CERCLA activities that satisfy the substantive DOE requirements eliminates the need for separate compliance actions.

The guidance for this requirement includes an enumeration of three key benefits:

- It avoids duplication of effort (i.e., the CERCLA process can be used to satisfy the requirements of DOE O 435.1);
- It eases the Environmental Protection Agency and State concerns about the overlap of CERCLA regulations and the Department requirements; and
- It enables the Department to better achieve its goals of ensuring managerial and financial control and fulfilling enforceable milestones.

For the remainder of this chapter, the term Disposal Authorization Statement will be used to encompass the option for disposal facilities to use a CERCLA ROD to document authorization for disposal rather than prepare a separate Disposal Authorization Statement.

4.2 Purpose of the Disposal Authorization

4.2.1 Facility Specific Conditions

The Disposal Authorization Statement verifies that the required radiological assessments have been performed and that they support the conclusion that the LLW disposal performance objectives will be satisfied. It also documents limits on design, construction, operations and closure for the subject disposal facility. The limits and conditions are to reflect the findings and conclusions of the PA and the CA. Approval of a Disposal Authorization Statement is also based on review of three additional facility-specific documents: 1) the PA and CA maintenance plan; 2) the preliminary closure plan; and 3) the preliminary monitoring plan.

4.2.2 Final Approval for Disposal

The granting of a disposal authorization is the final requirement that must be satisfied for approved disposal of DOE LLW. Preparation and approval of a disposal authorization relies on the findings and conclusions of the assessments and analyses, performed by the LFRG and the LFRG Review Team, that are designed to demonstrate that a disposal facility will not threaten the health or safety of humans or harm the environment.

4.3 Prerequisites to Disposal Authorization

This section describes the actions and any tangible results of those actions that must precede preparation and consideration for approval of a draft DAS.

4.3.1 Completed Documents

Low-level waste disposal facilities managed under the requirements of DOE O 435.1 are required to have the following final documents:

1) PA and CA prepared by the disposal site;

2) PA Review Report prepared by a Review Team appointed by the LFRG;

3) CA Compliance Evaluation prepared by the LFRG (may be combined with Item 5); and

4) PA and CA Maintenance Plan prepared by the disposal site.

LLW disposal facilities managed under the provisions of CERCLA are required to have the following final documents:

1) Written certification by the cognizant Field Element Manager (or his designee) that substantive requirements of the DOE M 435.1-1 have been satisfied through the CERCLA process.

2) A crosswalk or other written material linking specific elements of the CERCLA documentation to the substantive order requirements that they satisfy.

3) Documentation, analyses, or other information on compliance for any substantive order requirement for which compliance is not demonstrated through the CERCLA process. Included among this documentation may be a CA, provided the CERCLA analysis of interacting source terms is not of sufficient scope and rigor to satisfy the DOE O requirement for a CA.

4.3.2 Preliminary Documents

The development of certain documents will necessitate an iterative process and final versions of them cannot reasonably be required as prerequisites to granting disposal authorization for new disposal facilities. Therefore, only preliminary versions of such documents must be prepared prior to granting disposal authorization. However, subsequent timely revision of these documents may be included as a condition of the approved Disposal Authorization Statement. The documents are the following:

1) Preliminary Monitoring Plan

2) Preliminary Closure Plan

4.3.3 Reviewed Documents

Several of the required documents listed in Section 4.3.1 above, are products of the review of other documents. The reviews on which those documents are based must be performed according to the requirements of DOE policy and orders. Guidance on the review process and criteria is detailed in other documentation supporting oversight of LLW disposal facilities. For example, the process and criteria for review of PAs and CAs are described at length in Section 2 of this manual.

In addition to the primary review parties, other interested and affected parties will be offered opportunities to review documents. Host site personnel will have a stake in reviews of all of the cited documents. However, the purpose of and response to the reviews by non-primary parties will vary. For example, review and comment by the host site of the LFRG Review Team reports, has bearing on their factual content, but is not relevant in disputing the opinions and views expressed by the LFRG Review Team.

4.3.4 Actions

Actions that must be completed prior to drafting and submitting the disposal authorization to the cognizant Deputy Assistant Secretary are the following:

1) Approval by the cognizant Deputy Assistant Secretary of the PA for a facility managed under the requirements of DOE O 435.1.

2) Approval by the cognizant Deputy Assistant Secretary of the CA for a facility managed under the requirements of DOE O 435.1.

3) Review by the cognizant Deputy Assistant Secretary of appropriate CERCLA documentation for a facility managed under the requirements of CERCLA. In this context, the term "appropriate CERCLA documentation" means the written materials prepared to demonstrate compliance with the substantive low-level disposal requirements of DOE O.435.1. Specifically included in such written materials are crosswalks between CERCLA requirements and DOE O 435.1 requirements which are used as the basis for issuance of a disposal authorization by the cognizant Deputy Assistant Secretary.

4) Approval by the cognizant Deputy Assistant Secretary of any additional material demonstrating compliance with substantive requirements not met through the CERCLA process. For example, if the CERCLA process for evaluation of interacting sources does not satisfy the DOE requirement for a CA, then a separate CA must be prepared and approved by the cognizant Deputy Assistant Secretary.

4.4 Preparation of a Disposal Authorization Statement

4.4.1 Drafted by the LFRG

The disposal authorization is based on the PA and CA. Thus, it cannot be prepared until those documents are reviewed and approved. Three other documents that also need to be prepared and reviewed prior to drafting a Disposal Authorization Statement are (1) the Preliminary Monitoring Plan, (2) the Preliminary Closure Plan, and (3) the PA/CA Maintenance Plan. Upon completion of these actions, the Disposal Authorization Statement is to be prepared by the LFRG for consideration by the cognizant Deputy Assistant Secretary.

4.4.2 Guidance for Draft Preparation

The final Disposal Authorization Statement is not issued by the cognizant Deputy Assistant Secretary until both the PA and the CA have been approved and all conditions necessary for the disposal facility to follow as a result of both analyses have been determined. This could result in the completion of LFRG activities on some PAs in advance of those concerning the CA for the same facility.

If this occurs, the LFRG should modify the process to accommodate this event. A suggested approach is to develop the PA Compliance Evaluation for the disposal facility, conditionally approving the PA and allowing operations to continue. One condition of allowing operations to continue would specify the time of submittal of the final CA by the site. Conditions on the operation of the facility, until the CA is completed, should also be considered, such as limitations of acceptance of radionuclides that may be potentially critical radiation dose contributors in the CA.

The draft Disposal Authorization Statement should be prepared following the completion of the review and approval of both the PA and the CA. In this case, documentation on the facility accompanying the Disposal Authorization Statement, prepared by the LFRG, could include two Compliance Evaluations, one for the PA and one for the CA. The conditions in the draft Disposal Authorization Statement would be an appropriate consolidation of discussions from the

two Compliance Evaluations. If the PA/CA is revised, the Disposal Authorization Statement should be reviewed for possible revision.

4.4.3 Disposal Authorization Contents

Satisfaction of Performance Objectives

The DAS should unambiguously identify the facility and the design that is being authorized for operation. For example, if the PA and its conclusions are based on the use of an engineered barrier (e.g., concrete vault), the disposal authorization should clearly indicate that the authorization is for disposal in that type of facility and variations (e.g., trench disposal) are not covered by the PA and the disposal authorization.

The highest level element of the required disposal authorization is a declaration that analyses and documentation for the subject facility provide a reasonable expectation that the performance objectives described in the DOE O 435.1 will be satisfied. A related high level element of the required authorization is a declaration that the facility will not require subsequent corrective action or remedial action in order to continue to satisfy the performance objectives.

Facility-Specific Conditions

Items that are to be recorded in the Disposal Authorization Statement include all conditions and limitations imposed on the facility in the areas of design, construction, operations, and closure, and on maintenance of the analysis which supports authorization of the facility. Specific conditions and limitations should be considered for waste acceptance and receipt, waste form, monitoring, and record keeping. Documents that must be maintained (i.e., kept up-to-date) include the PA, CA, Disposal Authorization Statement, monitoring plan, maintenance plan, and the closure plan. Specific conditions requiring the conduct of certain monitoring, testing, or research may be invoked if deemed necessary to confirm parameter selection or assumptions on facility performance presented in the PA.

Facility-specific conditions may be derived through the results of the PA and the CA. In addition to constraining the site to those limits derived from the PA and/or CA, a condition may be imposed that requires that additional limitations on receipt or method of disposal of certain radionuclides be incorporated into site operating documents.

4.4.4 Disposal Authorization Review

The draft Disposal Authorization Statement may be prepared by one or more members of the LFRG or its support staff including the Review Team leader if a Review Team was established to review the PA and/or CA for the facility. Upon completion of the draft, it will be submitted for review and comment to the LFRG members and any Review Team leaders for the facility. Appropriate revisions will be performed and the revised draft will be submitted to the host site for review. Following incorporation of site comments, as appropriate, the final draft disposal authorization will be submitted to the cognizant Deputy Assistant Secretary for consideration.

4.4.5 Grantor of Final Approval

The disposal authorization will be approved or disapproved by the cognizant Deputy Assistant Secretary.

4.5 Maintenance Activities

Successful maintenance of the key documents describing expected performance of DOE LLW disposal facilities depends on three elements: (1) reviews and revisions of the PA and CA, (2) monitoring plans, (3) closure plans, (4) test and research activities related to the PA and CA, and (5) Annual Reviews. This section describes the requirements that support successful maintenance of the key documents and, in particular, the disposal authorization.

4.5.1 Regular Compliance Reviews

The principal source of guidance for maintenance of key documentation supporting operation of DOE LLW disposal facilities is the Maintenance Guide for U.S. Department of Energy Low-Level Waste Disposal Facility Performance Assessments and Composite Analyses. This document specifies annual reviews of the continued adequacy of the PA for each LLW disposal facility. Any changes to the PA necessitated by the annual reviews should be evaluated to determine if conforming changes to the disposal authorization are needed. A similar requirement for annual review of LLW disposal facility operations is included in DOE O 435.1, and a condition may be added to the disposal authorization that certain reviews be performed on a schedule other than the annual schedule.

In addition to the annual reviews, intermittent reviews may also be performed at the discretion of the LFRG or other Headquarters organizations with responsibilities for line management or independent oversight of LLW disposal facilities.

4.5.2 Monitoring

The monitoring and actual performance of a disposal facility can provide data that will confirm or refute the expected performance of a disposal facility. In addition to direct release data, monitoring can also provide refined parameters such as soil permeability and groundwater travel time required for performance models. Any such refined data should be used to update the modeling of performance and to determine whether changes are needed in key analyses such as the PA and CA. Necessary changes in those documents may be accompanied by conforming changes in the disposal authorization (if required) and may include changes in or additions to the conditions included in the disposal authorization for design, construction, operations, and closure of the facility.

4.5.3 Closure Plans

Closure Plans for LLW disposal facilities will probably change over the operational life of the facility. Initially, a preliminary closure plan is developed with assumptions of infiltration, longevity, etc. As more information is acquired concerning LLW disposal facility parameters and closure cap technology advances, the Closure Plan will need to be revised.

4.5.4 Research and Development

In addition to facility-specific data-gathering and refinement, research and development in waste disposal facility design, construction, operations, and closure can precipitate the need for revision of key documentation including the Disposal Authorization Statement.

4.5.5 Annual Reviews

Annual reviews of LLW disposal facility performance is necessary to ensure the LLW disposal facility is performing in accordance with the performance objectives delineated in DOE O 435.1. The annual reviews provide the LFRG reasonable assurance the facility is within the bounds of the DAS. The LFRG may decide, as a result of the annual review, to recommend to the cognizant Deputy Assistant Secretary to impose additional restrictions on facility operations through a modification to the Disposal Authorization Statement.

4.6 Records Management

The record keeping practices for LLW disposal facilities are to comply with the requirements of the Information Management and, QA Programs. For LLW disposal facilities managed under the requirements of CERCLA, the records management requirement of the CERCLA process will apply as well as following more specific guidance.

4.6.1 Records Retained

For a facility managed under DOE O 435.1 requirements, the following are the minimum suite of documents that must be retained and kept up-to-date for each such facility by the LFRG.

1) PA
2) CA
3) PA Review Plan
4) CA Review Plan
5) PA Review Report
6) CA Review Report
7) PA Compliance Evaluation
8) CA Compliance Evaluation
9) Disposal Authorization Statement
10) PA/CA Monitoring Plans
11) Closure Plans
12) Annual Reviews

For a DOE LLW disposal facility managed under the provisions of CERCLA, any of the documents above that are prepared for the facility must be retained. In addition, if the facility record of decision serves as the written disposal authorization, it must be retained as well as the crosswalk or documentation that demonstrates which actions and documentation of the CERCLA process indicate compliance with the substantive requirements of DOE radioactive waste management manual 435.1

Appendix A - LFRG Charter

CHARTER

OFFICE OF ENVIRONMENTAL MANAGEMENT LOW-LEVEL WASTE FEDERAL REVIEW GROUP

I. Mission

The Office of Environmental Management (EM) Low-Level Waste Federal Review Group (LFRG) was established to fulfill the requirements contained in Section I.2.E(1)(a) of DOE Order 435.1 and exercised by the upper-level managers of the Office of Environmental Management (EM). The LFRG assists upper-level EM managers in the review of documentation related to the approval of performance assessments and composite analyses or appropriate Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) documentation as described in Section II of this charter. Through its efforts, the LFRG supports the issuance of Disposal Authorization Statements for low-level radioactive waste disposal. The LFRG also assists in other duties associated with low-level waste (LLW) disposal authorizations as assigned by upper-level EM managers.

II. Objectives

Through the establishment and implementation of the LFRG process, the Department evaluates operational suitability of DOE disposal facilities through compliance with DOE LLW disposal requirements. The LFRG process supports the self-regulation responsibility imposed on the Department of Energy (DOE) under the Atomic Energy Act of 1954 as amended.

The specific objectives of the LFRG are:

- Track the preparation and completion status of documents prepared to demonstrate compliance with DOE LLW disposal requirements and report this information to upper-level EM managers;
- Develop and conduct a formal review process that documents an auditable analysis and review of key documents and provides for creation and maintenance of the administrative record of the LFRG and its actions;
- Review documentation submitted by LLW disposal facility host sites and support the process of granting Disposal Authorization Statements;
- Provide the cognizant upper-level EM managers with approval recommendations that represent the decisions of the LFRG membership;
- Prepare Disposal Authorization Statements, with conditions when justified, for DOE LLW disposal facilities; and
- Conduct reviews and assessments as directed by upper-level EM managers and provide recommendations.

The key documents, utilized to support development and approval of Disposal Authorization Statements for DOE LLW disposal facilities, consist of one of two document sets: (1) an approved performance assessment and composite analysis; or (2) appropriate CERCLA documentation that demonstrates compliance with the substantive requirements of DOE Order 435.1. Demonstration of compliance through the appropriate CERCLA documentation shall be summarized with a crosswalk that identifies each DOE LLW requirement satisfied by CERCLA. Substantive DOE LLW requirements unsatisfied by CERCLA are to be complied with separately. The LFRG is responsible for the determination of the adequacy of CERCLA documentation and for demonstrating compliance with DOE LLW requirements.

Based upon the review of either document set, a disposal authorization statement is prepared by the LFRG for consideration by the cognizant upper-level EM manager. Upon approval, the disposal authorization statement is signed by the cognizant upper-level EM manager.

III. Organization

The Co-Chairs of the LFRG are appointed by upper-level EM managers from among their staffs. The Co-Chairs are responsible for establishing and maintaining LFRG membership and establishing operating procedures, conducting meetings, and communicating results of LFRG deliberations to affected sites and to upper-level EM managers. Procedures, responsibilities, schedules, and other appropriate information for organization and operation of the LFRG will be documented in the LFRG Program Management Plan.

Members of the LFRG are recruited by the Co-Chairs in consultation with upper-level EM managers. The membership of the LFRG shall consist of Federal employees from Headquarters and field organizations. A representative from the DOE Office of Environment, Safety and Health (EH) shall serve on the LFRG to provide environment, safety, and health technical expertise. Members of the LFRG are expected to be competent in the technical evaluation of the documentation to be reviewed by the LFRG, to possess expertise in policy analysis, and to hold positions that authorize them to act on behalf of their respective organizations. The members of the LFRG are responsible for participation in the meetings of the LFRG and other activities as directed by the Co-Chairs. Continued membership on the LFRG is dependent upon adequate participation and timely review of documentation as determined by the Co-Chairs. Members of the LFRG shall serve until replaced or removed by the Co-Chairs. A review team is established for each specific site review.

A review team leader is selected by the LFRG Co-Chairs in consultation with the LFRG members and must be a Federal employee. The review team leader selects the balance of review team members with the concurrence of the Co-Chairs. Review team members are selected based on their qualifications for addressing key elements of the documentation to be reviewed. One or more of the review team members will be an LFRG member.

IV. Quorum and Voting

The desired quorum for deliberations by the full LFRG is a majority of the current membership (which includes the Co-Chairs). The LFRG Co-Chairs seek a consensus on the decisions of the LFRG. Ultimately, decisions are approved by affirmative vote of a simple majority of the LFRG members and Co-Chairs. Minority reports may be appended to records of LFRG decisions at the request of any member or Co-chair. Only LFRG members have voting rights. These rights may not be delegated to individuals participating in LFRG activities as representatives of the members.

In instances when a majority cannot be achieved, the LFRG Co-Chairs may jointly act on behalf of the LFRG. Decisions made solely by the Co-Chairs on behalf of the majority must be documented in writing and noted as having been made by the Co-Chairs rather than by majority.

V. Authorizations

Mark W. Frei
Acting Deputy Assistant Secretary
for Waste Management

James J. Fiore
Acting Deputy Assistant Secretary
for Environmental Restoration

VI. Concurrences

Jay Rhoderick
LFRG Co-Chair

William E. Murphie
LFRG Co-Chair

LFRG Charter, 9/1/99

Appendix B – Definitions

Definitions

ACUTE EXPOSURE SCENARIOS. Acute exposure scenarios are hypothetical situations developed for the purpose of forecasting the radiation doses that inadvertent intruders could receive due to a short-term, high-intensity exposure to waste from a closed disposal facility.

ALPHA LOW-LEVEL WASTE. Alpha low-level waste is low-level waste that contains transuranic radionuclides in concentrations over 10 nanocuries per gram but less than 100 nanocuries per gram. (Waste in which the concentration of transuranic radionuclides is greater than 100 nanocuries per gram is generally classified as transuranic waste.)2

CHRONIC EXPOSURE SCENARIOS. Chronic exposure scenarios are hypothetical situations developed for the purpose of forecasting the radiation doses that inadvertent intruders could receive due to long-term, relatively low exposures to waste from a closed disposal facility.

CLOSURE. Deactivation and stabilization of a radioactive waste facility intended for long-term confinement of waste. [DOE Manual 435.1]

COGNIZANT DEPUTY ASSISTANT SECRETARY. For a low-level waste disposal facility, the cognizant deputy assistant secretary is the one to whom operators of the facility ultimately report through normal line management chains.

COMPLIANCE EVALUATION. A compliance evaluation is a written evaluation prepared by the Low-Level Waste Federal Review Group to document the acceptability of a performance assessment, a composite analysis, or both for a specific disposal facility.

COMPOSITE ANALYSIS. An analysis that accounts for all sources of radioactive material that may contribute to the long-term dose projected to a hypothetical member of the public from an active or planned low-level waste disposal facility. The analysis is a planning tool intended to provide a reasonable expectation that current low-level waste disposal activities will not result in the need for future corrective or remedial actions to ensure protection of the public and the environment. [DOE Manual 435.1]

DISPOSAL. Emplacement of waste in a manner that ensures protection of the public, workers, and the environment with no intent of retrieval and that requires deliberate action to regain access to the waste. [DOE Manual 435.1]

DISPOSAL AUTHORIZATION STATEMENT. Documentation authorizing operation (or continued operation) of a low-level waste disposal facility resulting from the DOE Headquarters review and acceptance of the facility's performance assessment, composite analysis, and other information and evaluations. The disposal authorization statement constitutes approval of the performance assessment and composite analysis, authorizes operation of the facility, and includes conditions the disposal facility must meet. [DOE Manual 435.1]

LOW-LEVEL WASTE. Low-level radioactive waste is radioactive waste that is not high-level radioactive waste, spent fuel, transuranic waste, byproduct material (as defined in Section 11.e(2) of the *Atomic Energy Act of 1954*, as amended), or naturally occurring radioactive material. [DOE Manual 435.1]

LOW-LEVEL WASTE FEDERAL REVIEW GROUP. The Low-Level Waste Federal Review Group was chartered by the two Deputy Assistant Secretaries in the DOE Office of Environmental Management who have principal line management responsibility for DOE low-level waste disposal facilities. Its primary purpose is to assist those Deputy Assistant Secretaries in reviewing assessments and analyses of low-level waste disposal facilities and making recommendations on their acceptability.

MIXED LOW-LEVEL WASTE. Low-level waste that contains both source, special nuclear or by-product material subject to the *Atomic Energy Act of 1954*, as amended, and a hazardous component subject to the *Resource Conservation and Recovery Act*. [DOE Manual 435.1]

PA/CA REVIEW PLAN. A plan prepared to organize the review of the performance assessment, the composite analysis, or both for a specific disposal facility. The plan is prepared by the Review Team empaneled to perform the review and is approved by the Low-Level Waste Federal Review Group.

PA/CA REVIEW REPORT. The written report of a Review Team describing the findings reached by the Review Team in the course of reviewing for a specific disposal facility the performance assessment, the composite analysis, or both.1

PERFORMANCE ASSESSMENT. An analysis of a radioactive waste disposal facility conducted to demonstrate there is a reasonable expectation that performance objectives established for the long-term protection of the public and the environment will not be exceeded following closure of the facility. [DOE Manual 435.1]

POINT OF ASSESSMENT. The physical location at which monitoring and modeling for facility performance are to be performed. The default point of assessment for a low-level waste disposal facility is the outer perimeter of a 100 meter wide buffer zone around the boundary of the disposal facility. A point of compliance closer to or further from the facility boundary may be used but justification is required. For example, the point of compliance for a disposal facility in a tract to be maintained under institutional control could be argued to be the boundary of the institutional control area.

RADIOACTIVE WASTE MANAGEMENT BASIS. The radioactive waste management controls applied to DOE facilities, operations, and activities to provide near- and long-term protection of public, workers, and the environment. The radioactive waste management basis consists of controls and analyses such as facility waste certification programs, facility waste acceptance requirements, low-level waste disposal facility closure plans, performance assessments, composite analyses and other facility-specific processes, procedures, and analyses made to comply with DOE O435.1 and its Manual. [DOE Manual 435.1]

WASTE ACCEPTANCE CRITERIA. Waste acceptance criteria are the technical and administrative requirements that a waste must meet in order for it to be accepted at a storage, treatment, or disposal facility. [DOE Manual 435.1]

WASTE ACCEPTANCE REQUIREMENTS. Waste acceptance requirements are waste acceptance criteria, and all other requirements that a facility receiving radioactive waste for storage, treatment, or disposal must meet to receive waste (e.g., waste acceptance program requirements, receiving facility operations manual). [DOE Manual 435.1]

WASTE DISPOSAL UNITS. A waste disposal unit is a discrete, essentially continuous volume in which waste is disposed and includes near-field engineered and natural barriers that separate it from other near-by waste disposal units.

Appendix C – References

Appendix C - References

1. *Conformance with Safety Standards at Department of Energy (DOE) Low-Level Nuclear Waste and Disposal Sites,* Recommendation 94-2, Defense Nuclear Facilities Safety Board, October 28, 1994.

2. *Format and Content Guide for U.S. Department of Energy Low-Level Waste Disposal Facility Performance Assessments and Composite Analyses* (Draft), U.S. Department of Energy, October 7, 1999.

3. *Guidance for Complying with DOE Order 5820.2A, Radioactive Waste Management, for Onsite Management and Disposal of Low-Level Wastes (LLW) Resulting from Environmental Restoration Activities*, U.S. Department of Energy, January 9, 1997.

4. *Guidance for a Composite Analysis of the Impact of Interacting Source Terms on the Radiological Protection of the Public from Department of Energy (DOE) Low-Level Waste Disposal Facilities*, U.S. Department of Energy, Office of Waste Management, April 1996.

5. *Implementation Guide for Use with DOE M 435.1-1*, Chapter IV, Low-Level Waste Requirements, July 1999.

6. Implementation Plan, DNFSB Recommendation 94-2, *Conformance with Safety Standards at Department of Energy (DOE) Low-Level Nuclear Waste and Disposal Sites,* U.S. Department of Energy, Office of Waste Management, Revision 1, April 1996.

7. Interim Format and Content Guide, and Standard Review Plan for U.S. Department of Energy Low-Level Waste Disposal Facility Performance Assessments, U.S. Department of Energy, Office of Waste Management, October 1996.

8. *Interim Review Process and Criteria for Department of Energy Low-Level Waste Disposal Facilities Composite Analyses*, U.S. Department of Energy, Office of Waste Management, October 1996.

9. *Limits for Intakes of Radionuclides by Workers,* International Commission on Radiological Protection, Committee 2, ICRP-30, Parts 1, 2, and 3, 1979, 1980, 1981.

10. *Maintenance of U.S. Department of Energy Low-Level Waste Performance Assessments*, September 1996.

11. *Policy for Demonstrating Compliance with DOE Order 5820.2A for Onsite Management and Disposal of Environmental Restoration Low-Level Wastes Under the Comprehensive Environmental Response, Compensation, and Liability Act*, U.S. Department of Energy, May 31, 1996.

12. *Radiation Protection of the Public and the Environment*, DOE Order 5400.5, U.S. Department of Energy,

13. *Radioactive Waste Management*, DOE Order 435.1, U.S. Department of Energy, July 1999

14. *Radioactive Waste Management*, DOE Order 5820.2A, U.S. Department of Energy, September 1988.

Appendix D
Confidentiality and Conflict of Interest Certification

Confidentiality and Conflict of Interest Certification

To ensure complete independence in performing the performance assessment and composite analysis review, as applicable, each Contractor on the DOE/LFRG Review Team shall agree to and execute an organizational conflict of interest certification statement as given below.

To: _____

From: _____

Regarding my involvement in review of the following project:

_____

(Name of Disposal Facility)

I certify that I will not disclose, except pursuant to the order of a court of competent jurisdiction, any information regarding the subject procurement either during solicitation or evaluation of quotations/proposals, or any subsequent time, to anyone who does not have authorized access to the information, and then only to the extent that such information is required in connection with such person's official responsibilities. I also certify that:

1. I shall not use "privileged information" acquired through my participation in this process for personal gain.
2. I do not have any financial interest that conflicts substantially, or even appears to do so, with duties associated with this process.
3. Neither I, my spouse, nor my child will accept anything of monetary value from any person or company seeking to do business through this project review. (Even seemingly trivial courtesies can present the appearance of impropriety or create a subtle sense of obligation and must be avoided.)
4. I have not participated in any activities or conversations with any parties that would give any potential offeror an unfair competitive advantage on this project review.
5. There are no personal or professional interests, influences, or issues, that will affect my ability to render an impartial, unbiased, and fair evaluation and recommendations.

_____

Signature

_____

Print Name

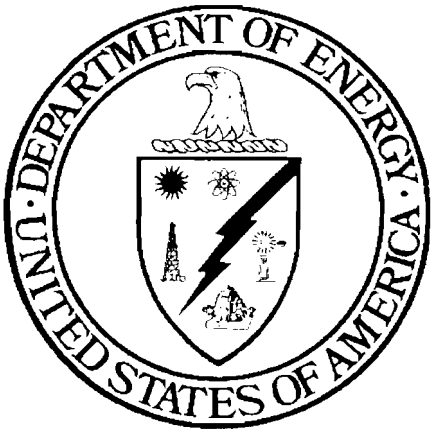
_____

Date

Appendix E
LFRG Qualification

Draft 5/24/06

Qualification for Low-Level Waste Disposal Facility Federal Review Group (LFRG) Members



U.S. Department of Energy
Washington, D.C. 20585

APPROVAL

The Low-Level Waste Disposal Facility Federal Review Group (LFRG) consists of senior Department of Energy representatives responsible for overseeing the low-level radioactive waste disposal program as delineated in DOE Order 435.1, Radioactive Waste Management. This Group is responsible for reviewing and approving individual site's Performance Assessments and Composite Analyses. They are also responsible for recommending approval of Disposal Authorization Statements to the appropriate Deputy Assistant Secretary. This qualification has been developed to ensure the individuals performing these duties are competent and well qualified.

_____

Chairman, LFRG

TABLE OF CONTENTS

ACKNOWLEDGMENT

The Office of Environmental Management is the Sponsor for the LFRG Qualification. The Sponsor is responsible for coordinating the development and/or review of this Qualification by subject matter experts to ensure that the technical content of the Qualification is accurate and adequate for Department-wide application for those involved in the LFRG. The Sponsor, in coordination with the LFRG Committee, is also responsible for ensuring the Qualification is maintained current.

The following subject matter experts (SMEs) participated in the development and/or review of this Qualification:

Martin Letourneau	Office of Environmental Management (EM-5)
Mary Willcox	Idaho Operations Office
Andy Wallo	Office of Environment, Safety and Health (EH-41)
Howard Pope	Savannah River Operations Office

U.S. DEPARTMENT OF ENERGY
LFRG QUALIFICATION

PURPOSE

On June 27, 1997, the Deputy Assistant Secretaries for Waste Management and Environmental Restoration in the Office of Environmental Management established the Low-level Waste Disposal Facility Federal Review Group (LLFRG) to develop and implement a review process for low-level radioactive waste (LLW) disposal facility Performance Assessment (PA) and Composite Analyses (CA). The LFRG was chartered with providing management with the necessary information to determine if low-level waste disposal facilities are designed, constructed, operated, maintained, and closed in a manner that protects the public and environment. The Department established the LFRG as the Department's regulatory oversight group for reviewing PAs and CAs. The LFRG consists of Federal employees from Headquarters and Field organizations. Members are selected to ensure the LFRG reflects the policy, technical, regulatory, and programmatic perspectives necessary to conduct effective PA and CA review.

The LFRG is committed to continuously strive for technical excellence. DOE's Technical Qualification Program, along with the supporting Technical Qualification Standards, complements the LFRG Qualification. In support of this goal, the competency requirements defined in these qualification standards should be aligned with and integrated into the recruitment and staffing processes for the LFRG.

This qualification is not intended to replace the OPM Qualifications Standards nor other Departmental personnel standards, rules, plans, or processes. The primary purpose of this qualification is to ensure that employees have the requisite technical competency to support the mission of the LFRG.

APPLICABILITY

This Qualification establishes common competency requirements for Department of Energy personnel who provide assistance, direction, guidance, oversight, or evaluation of contractor technical activities impacting the safe operation of DOE's low-level waste disposal facilities. This Qualification has been developed as a tool to assist DOE Program and Field offices in the development of personnel who will be assigned LFRG responsibilities as delineated in DOE Order 435.1. Satisfactory and documented attainment of the competency requirements contained in this Qualification ensures that personnel possess the requisite competence to fulfill their LFRG duties and responsibilities.

IMPLEMENTATION

The Technical Functional Area Qualification Standards identify the technical competency requirements for Department of Energy personnel. Although there are other competency requirements associated with the positions held by DOE personnel, this Qualification is limited to identifying the specific technical competencies for LFRG members. The competency statements define the expected knowledge and/or skill that an individual must meet. Each of

the competency statements is further explained by a listing of supporting knowledge and/or skill statements. The competencies listed in this Qualification are similar to competencies identified in the Functional Area Qualification Standards. If individuals already possess a certification for these competencies in a Functional Area Qualification Standard, it is not necessary for individuals to "re-qualify" in these competencies.

The competencies identify a familiarity level, a working level, or an expert level of knowledge; or they require the individual to demonstrate the ability to perform a task or activity. These levels are defined as follows:

Familiarity level is defined as basic knowledge of or exposure to the subject or process adequate to discuss the subject or process with individuals of greater knowledge.

Working level is defined as the knowledge required to monitor and assess operations/activities, to apply standards of acceptable performance, and to reference appropriate materials and/or expert advice as required to ensure the safety of Departmental activities.

Expert level is defined as a comprehensive, intensive knowledge of the subject or process sufficient to provide advice in the absence of procedural guidance.

Demonstrate the ability is defined as the actual performance of a task or activity in accordance with policy, procedures, guidelines, and/or accepted industry or Department practices.

Headquarters and Field elements shall establish a program and process to ensure that DOE personnel possess the competencies required for the LFRG position. This includes the competencies identified in the appropriate Technical Functional Area Qualification Standard and the LFRG Qualification. Documentation of the completion of the requirements of the associated Standard/Qualification shall be included in the employee's training and qualification record.

Equivalencies may be granted for individual competencies based upon an objective evaluation of the employee's prior education, experience, and/or training. Equivalencies shall be granted in accordance with the policies and procedures of the program or field office. The supporting knowledge and/or skill statements, while not requirements, should be considered before granting equivalency for a competency.

Training (formal and/or on-the-job) shall be provided to employees who do not meet the competencies contained in this Qualification. Training will be based upon appropriate supporting knowledge and/or skill statements similar to the ones listed for each of the competency statements. Headquarters and Field elements should use the supporting knowledge and/or skill statements as a basis for evaluating the content of any training courses used to provide individuals with the requisite knowledge and/or skill required to meet the LFRG Qualification competency statements.

EVALUATION REQUIREMENTS

Attainment of the competencies listed in this qualification should be documented by a qualifying official, immediate supervisor, or LFRG team member of personnel using any of the following methods:

- Documented evaluation of equivalencies
- Written examination
- Documented oral evaluation
- Documented observation of performance

CONTINUING EDUCATION, TRAINING AND PROFICIENCY

LFRG personnel shall participate in continuing education and training as necessary to improve their performance and proficiency and ensure that they stay up-to-date on changing technology and new requirements. This may include courses and/or training provided by:

- Department of Energy
- Other government agencies
- Outside vendors
- Educational institutions

A description of suggested learning proficiency activities, and the requirements for the continuing education and training program for LFRG personnel are included in Appendix A of this document.

DUTIES AND RESPONSIBILITIES

The following are the typical duties and responsibilities expected of personnel assigned to the LFRG:

1. Develops site specific Performance Assessment (PA), Composite Analysis (CA) and associated documents in compliance with DOE Order 435.1 and it's associated Manual and Guide.

2. Reviews technical data/documents associated with the development and/or implementation of PA/CA or associated documents.

3. Reviews and implements LLW management policy, requirements and guidance.

4. Evaluates LLW management programs to determine whether the program complies with DOE Order 435.1 and it's associated Manual and Guide.

5. Appraises LLW facilities, procedures, and operations to determine their adequacy to protect members of the general public and the environment.

6. Provides technical assistance and advice in the area of LLW management to other organizations and independent review groups.

7. Reviews Office and/or contractor performance to identify trends indicative of LLW performance or compliance status.

8. Reviews and comments on a wide variety of operating contractor documents such as waste acceptance criteria, Radioactive Waste Management Basis, etc.

BACKGROUND AND EXPERIENCE

The U. S. Office of Personnel Management's Qualification Standards Handbook establishes minimum education, training, experience, or other relevant requirements applicable to a particular occupational series/grade level, as well as alternatives to meeting specified requirements.

The preferred education and experience for LFRG personnel is:

1. Education:

   Bachelor of Science degree in engineering or physical science from an accredited Institution or meet the alternative requirements specified in the Qualification Standards Handbook for the GS-1300, Physical Scientist and Health Physics Series; GS-800, General Engineer series; and the GS-400, Biological Sciences series.

2. Experience:

   Industry, facility, operations, other Federal related experience that has demonstrated background in waste, environmental or project management.

REQUIRED TECHNICAL COMPETENCIES

The competencies contained in this Qualification are distinct from those competencies contained in the General Technical Base Qualification Standard and may be repetitive in the Functional Area Qualification Standard. All LFRG personnel must satisfy the competency requirements of the General and an appropriate Functional Area Technical Base Qualification Standard prior to or in parallel with the competency requirements contained in this standard. Each of the competency statements define the level of expected knowledge and or skill that an individual must posses to meet the intent of this standard. The supporting knowledge and/or skill statements further describe the intent of the competency statements.

For competencies 1through 8 (Scientific and Technical Competencies), LFRG personnel must have at least a familiarity level in all 8 competencies and a working level knowledge of at least .

Note: When regulations or Department of Energy directives or other industry standards are referenced in the Qualification, the most recent revision should be used.

Scientific and Technical Qualifications

Chemistry

1. LFRG personnel shall demonstrate a working level knowledge of chemistry fundamentals.

Supporting Knowledge and/or Skills

a. Discuss the following types of chemical bonds:

- Ionic
- Covalent
- Metallic

b. Discuss how elements combine to form chemical compounds.

c. Define and discuss the following terms:

- Mixture
- Solvent
- Solubility
- Solute
- Solution
- Equilibrium
- Density
- Molarity
- Parts per million (ppm)
- Acid
- Base
- Salt
- pH

Statistics

2. LFRG personnel shall demonstrate a working level knowledge of probability and simple statistics.

Supporting Knowledge and/or Skills

a. State the definition of the following statistical terms:

- Mean
- Variance
- Standard deviation of the mean
- Median
- Mode
- Standard deviation
- Nonparametric

b. Explain the structure and function of distributions.

c. Calculate the mathematical mean of a given set of data.

d. Calculate the mathematical standard deviation of the mean of a given set of data.

e. Given the data, calculate the probability of an event.

f. Describe how measures of samples (i.e., measures of central tendency and variability) are used to estimate population parameters through statistical inference.

g. Discuss Type I and Type II decision errors and the relationship to sampling and confidence levels.

h. Discuss similarities and differences in probabilistic versus deterministic analyses.

i. Discuss uncertainty and sensitivity analyses

Hydrology, Geology, and Soil Science

3. LFRG personnel shall demonstrate a working level knowledge of the basic principles and concepts of hydrology, geology, and soil science.

Supporting Knowledge and/or Skills

a. List the different soil textures (compositions) and soil structures.

b. Define humus and explain its role in chemical reactions in the soil.

c. Define erosion and describe the characteristics and effects of water and wind erosion.

d. Describe the following processes and explain how water and soil interact in each:

- Infiltration and percolation
- Groundwater recharge
- Runoff
- Evapotranspiration

e. Describe how soil characteristics, slope factors, and land cover conditions impact the detachment and transport processes of pollution.

f. Discuss pollutant loading and the pollutant delivery ratio.

g. Discuss the use of soil survey maps.

h. Discuss the cation and anion exchange capacity of soils.

i. Describe the hydrologic cycle.

j. Define the following hydrologic terms and describe the relationships between them:

- Precipitation
- Stream flow
- Evaporation
- Transpiration
- Sedimentation

k. Define the following groundwater terms and describe the relationships between

them:

- Capillary water
- Zone of saturation
- Specific yield
- Hydraulic conductivity
- Transmissivity
- Vadose zone

l. Define the following surface water terms:

- Mass curve
- Frequency analysis
- Watershed

m. Discuss the composition and identification of the following types of rocks and cite examples of each.

- Igneous
- Sedimentary
- Metamorphic

n. Describe the geometry and properties of the following rock structures or features:

- Folds
- Faults
- Structural Discontinuities
- Residual Stress
- Sheet Joints
- Structural discontinuities
- Shear strength of discontinuities
- Residual stress
- Sheet joints

o. Discuss the use of geological and geotechnical maps.

p. Describe the geologic considerations, criteria and procedures used to evaluate the following:

- Relief
- Slope stability
- Flood plains
- Karst terrain

q. Discuss weathering and its significance in geotechnical engineering.

r. Discuss tests that assess weatherability.

s. Discuss the process for interpreting rock cores.

t. Describe how different soil types can affect contaminant transport.

u. Describe the effect partition coefficients can have on contaminant transport.

Meteorology

4. LFRG personnel shall demonstrate a working level knowledge of the basic principles and concepts of meteorology.

Supporting Knowledge and/or Skills

a. Discuss the meteorological conditions associated with the occurrence of maximum ground-level concentrations for elevated releases of pollution, and for ground releases.

b. Describe the classes of atmospheric stability in the atmospheric dispersion system developed by Pasquill, Gifford and Turner.

c. Describe the role of lapse rate in determining dispersion coefficients.

d. Describe how buildings and terrain affect the diffusion of gases.

eDescribe the most important parameters that affect the calculation of dose from an airborne radioactive plume.

f. Describe the kind of information given by a wind rose.

Environmental Science

5. LFRG personnel shall demonstrate a working level knowledge of the basic terms and concepts of environmental biology.

Supporting Knowledge and/or Skills

a. Define the following terms:

- Ecosystem
- Biota
- Community
- Habitat
- Species
- Pathways analysis
- Bioaccumulation
- Bioconcentration
- Biotoxicity
- Biodiversity
- Population
- Threatened & Endagered Species
- Allotmetric Relationships
- Dose Rate

- Radioecology
- Conceptual Model
- Ecological Risk Assessment
- Radiation Effects to Biota
- Ecological Benchmarks

b. Define synergism and discuss our ability to quantify cause and effect relationship for multiple chemical and radiological stressors to biota.

c. Discuss spatial and temporal considerations in evaluating chemical and radiological impacts to biota.

d. Discuss some of the internal and external exposure pathways to biota in evaluating chemical and radiological stressors.

Monitoring

6. LFRG personnel shall demonstrate a familiarity level knowledge of monitoring techniques related to environmental compliance.

Supporting Knowledge and/or Skills

a. Describe the types of equipment used to monitor a site for the following:

- Ambient air quality
- Emissions
- Groundwater contamination
- Meteorological factors
- Streams and rivers contamination
- Soil and sediment contamination
- Wildlife contamination

b. Describe the requirements of the following documents as they relate to environmental monitoring:

- Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA)
- Resource Conservation and Recovery Act (RCRA)
- National Environmental Policy Act (NEPA)
- 40 CFR 61, National Emission Standards for Hazardous Air Pollutants (NESHAP)
- DOE M 435.1-1 and associated guidance document DOE G 435.1-1

c. Describe the various quality assurance and quality control programs used to enhance data quality. Include in your discussion programs both internal and external to the Department.

d. Describe the standard methods for the examination of water and wastewater.

e. Given a sampling parameter/equipment, describe the standard sampling methods and protocols.

7. LFRG personnel shall demonstrate a familiarity level knowledge of the purpose and uses of environmental sampling and monitoring equipment.

Supporting Knowledge and/or Skills

a. Explain the reason for measuring emissions, meteorological factors and ambient air quality under various operation conditions (e.g., routine and emergency).

b. Describe the purpose and limitations of the following air quality measurement instruments:

- High volume particulate sampler
- Liquid bubbler (e.g., for sulfur dioxide)
- Infrared spectrometer

c. Describe the purpose and types of material collected by the following sampling media:

- High efficiency glass fiber filter
- Activated charcoal cartridge
- Silica gel

d. Describe the purpose for measuring each of the following parameters during field surveys of water quality:

- Temperature
- Dissolved oxygen
- Conductivity
- pH

e. Discuss the factors that can affect readings and the preservation methods for the field measurements listed above.

f. Describe how trace toxic organics in water are assayed by gas chromatography.

g. Describe how heavy metals in water are measured using atomic absorption spectro-photometry.

h. Describe how volatile organics are measured.

i. Identify the types of data and records required to be retained as permanent records.

Risk and Radiological Dose Assessment and Management

8. LFRG personnel shall demonstrate familiarity or working level knowledge of radiation protection concepts and dose assessment.

Supporting Knowledge and/or Skills

a. Define the following radiation protection related terms:
    - Absorbed dose

- Collective dose equivalent
- Collective effective dose equivalent
- Committed dose equivalent
- Deep dose equivalent
- Dose equivalent
- Effective dose equivalent
- Weighting factor
- Reference Man

b. Discuss the three basic elements of radiation protectionin context of DOE Low-level waste disposal (Justification, dose limitation and optimization)
c. What information are contained in Federal guidance reports #11, #12, and #13 and their application to dose and risk assessment.
d. Discuss internal and external exposure and associated pathways.
e. Discuss some of the factors that should be considered regarding the use and interpretation of national vs. regional/site-specific environmental parameter distributions and their application in Monte Carlo analysis to support probabilistic dose or risk assessments.

9. LFRG personnel shall demonstrate a working level knowledge of the principles, concepts, and requirements of environmental risk assessment.

Supporting Knowledge and/or Skills

a. Define risk assessment, risk management, and risk communication.

b. Describe the four steps of a risk assessment.

c. Describe how risk assessment helps in site decision-making.

d. Define the term "Baseline Risk Assessment."

e. Describe the process for a Toxicity Assessment.

f. Describe the process for an Exposure Assessment.

g. Describe the process used to characterize risk.

h. Identify the types of data and records required to be retained as permanent records.

Regulatory Related

10. LFRG personnel shall demonstrate a familiarity level knowledge of the purpose and requirements of DOE O 5400.5, Radiation Protection of the Public and Environment.

Supporting Knowledge and/or Skills

a. State the Department's policy and discuss the objectives regarding the protection of the public and the environment from radiation as contained in DOE O 5400.5.

b. Define the following terms:

- As low as reasonably achievable (ALARA)
- Best available technology (BAT)
- Derived concentration guide (DCG)
- Effective dose equivalent in DOE 5400.5 and DOE M 435.1-1 versus Total Effective Dose equivalent in 10CFR Part 20
- Public dose
- Weighting factor
- Quality factor
- Effluent monitoring
- Environmental surveillance
- Protective action guides
- Release of property
- Residual radioactive material
- Settleable solids
- Soil column

c. List and discuss the factors that must be considered pertaining to the release of materials and equipment having residual radioactive material as outlined in Chapter IV of the Order, Residual Radioactive Material Cleanup.

d. Identify and discuss the release criteria for:

- soil
- air/water
- surface
- real property
- personal property

In the discussion, relate the implications low-level waste of property containing residual radioactive material that meet DOE 5400.5 criteria vs property that exceeds criteria or authorized limits.

11. LFRG personnel shall demonstrate the ability to appraise the contractor's program(s) to assess compliance with the requirements for environmental radiation protection.

Supporting Knowledge and/or Skills

a. Assess whether the effluent monitoring from a facility meets the requirements of DOE O 5400.5, Radiation Protection of the Public and the Environment.

b. Assess whether adequate methods are used to characterize effluents for purposes of limiting doses to the public in accordance with regulatory and "as low as reasonably achievable (ALARA)" limits.

c. Assess whether the Environmental Radiological Protection Program is in accordance with DOE O 5400.5, Radiation Protection of the Public and Environment.

d. Identify the types of data and records required to be retained as permanent records.

Authorization Basis Documentation

12. LFRG personnel shall demonstrate a familiarity level knowledge of Documented Safety Analyses as described in 10 CFR 830, Subpart B, Nuclear Safety Management.

Supporting Knowledge and/or Skills

a. Discuss the basic purposes and objectives of Nuclear Safety Analysis Reports.

b. Describe the responsibilities of contractors authorized to operate defense nuclear facilities regarding the development and maintenance of a Nuclear Safety Analysis Report.

c. Define the following terms and discuss the purpose of each:

- Design basis
- Authorization basis
- Engineered safety features
- Safety analysis
- Safety systems

d. Describe the requirements for the scope and content of a Nuclear Safety Analysis Report and discuss the general content of each of the required sections of a Nuclear Safety Analysis Report.

e. Discuss the ways that contractor management makes use of Nuclear Safety Analysis Reports.

13. LFRG personnel shall demonstrate a familiarity level knowledge of Department of Energy (DOE) Technical Standard DOE-STD-1027, Hazard Categorization and Accident Anaylsis Techniques.

Supporting Knowledge and/or Skills

a. Using DOE-STD-1027 as a reference, discuss its purpose, applicability, and scope.

b. State the three levels of facility hazard categorization.

14. LFRG personnel shall demonstrate familiarity level knowledge of Unreviewed Safety Question requirements as described in 10 CFR 830, Subpart B, Nuclear Safety Management.

Supporting Knowledge and/or Skills

a. Discuss the reasons for performing an unreviewed safety question determination.

b. Define the following terms:

- Accident analyses

- Safety evaluation
- Technical safety requirements

c. Describe the situations which require a safety evaluation to be performed.

d. Define the conditions for an unreviewed safety question.

e. Describe the responsibilities of contractors authorized to operate defense nuclear facilities for the performance of safety evaluations.

f. Describe the action(s) to be taken by a contractor upon identifying information that indicates a potential inadequacy of previous safety analyses or a possible reduction in the margin of safety as defined in the technical safety requirements.

g. Discuss the action(s) to be taken if it is determined that an unreviewed safety question is involved.

h. Discuss the qualification and training requirements for personnel who perform safety evaluations.

15. LFRG personnel shall demonstrate familiarity level knowledge of the technical safety requirements as described in 10 CFR 830, Subpart B, Nuclear Safety Management.

Supporting Knowledge and/or Skills

a. Discuss the purpose of technical safety requirements.

b. Describe the responsibilities of contractors authorized to operate defense nuclear facilities for technical safety requirements.

c. Define the following terms and discuss the purpose of each:

- Safety limit
- Limiting control settings
- Limiting conditions for operation
- Surveillance requirements

d. Describe the general content of each of the following sections of the technical safety requirements:

- Use and application
- Safety limits
- Operating limits
- Surveillance requirements
- Administrative controls
- Design features

e. Discuss the conditions that constitute a violation of the technical safety requirements and state the reporting requirements should a violation occur.

Environmental Laws and Regulations

16. LFRG personnel shall demonstrate a familiarity level knowledge of the Clean Air Act (CAA) and implementing regulations.

Supporting Knowledge and/or Skills

a. Discuss the application of the Clean Air Act to the Department of Energy and its facilities.

b. Discuss the radiological NESHAPs applicable to DOE activities:
40CFR Part 61 Subpart H and
40CFR Part 61 Subpart Q

17. LFRG personnel shall demonstrate a familiarity level knowledge of the following laws ,directives and regulations as related to the environmental medium of water:

- Clean Water Act (CWA)
- Safe Drinking Water Act (SDWA)
- Resource Conservation and Recovery Act (RCRA) (groundwater provisions)
- Oil Pollution Act

Supporting Knowledge and/or Skills

a. Discuss the application of the above laws to the Department of Energy and its facilities.

b. Discuss the limitations of CWA regulation with regard to radionuclides

d. Describe the reporting requirements identified in the Clean Water Act.

e. Discuss the standards for maximum contaminant levels (primary and secondary) contained in the Safe Drinking Water Act.

f. Discuss the storm water aspects of the NPDES.

g. Identify the requirements in the National Pollutant Discharge Elimination System that apply to waste management.

h. Discuss the approach to surface water and groundwater protection required in DOE O450.1 and how it relates to LLW disposal.

18. LFRG personnel shall demonstrate a familiarity level knowledge the following National Environmental Policy Act documentation:

- Environmental Impact Statement (EIS)
- Environmental Assessment (EA)
- Finding Of No Significant Impact (FONSI)
- Categorical Exclusion (CX)
- Record of Decision (ROD)

Supporting Knowledge and/or Skills

a. Discuss the content and procedures specified by the Department implementing regulations 10 CFR 1021, Compliance with the National Environmental Policy Act and Secretarial Policy on the National Environmental Policy, June 13, 1994.

b. Discuss the different areas that are analyzed in an EIS to determine the affect on the environment (i.e. geologic resources, groundwater, meteorology, ecological, public health and safety, etc.)

19. LFRG personnel shall demonstrate a expert level knowledge of DOE authorities and responsibilities related to LLW management derived from:

- Atomic Energy Act
- Low Level Waste Policy Amendment Act
- The Energy Reorganization Act of 1974
- The Department of Energy Organization Act
- Energy Policy Act of 2005

Supporting Knowledge and/or Skills

a. Discuss the responsibilities of states and the federal government by Agency identified under the Atomic Energy Act.

b. Define the following terms and their implications for regulation in the Department of Energy:

- Agreement State
- Allocation
- Compact
- Sited Compact Region

c. Describe the federal government disposal responsibilities under the Low Level Waste Policy Amendment Act (LLWPAA).

d. Identify the federal government responsibilities for disposing of low level waste at a non-federal facility per the LLWPAA.

e. Discuss DOE, EPA and NRC radiation protection responsibilities and authorities.

f. Discuss Departmental authority and responsibility for the management and disposal of the low-level radioactive waste and discuss implications related to Naturally Occurring and Accelerator Produced radioactive waste and by-product material waste. Also, discuss differences between NRC and DOE authorities for similar wastes.

20. LFRG personnel shall demonstrate a familiarity level knowledge of the supporting environmental policies, laws and regulations including:

- Federal Insecticide, Fungicide, and Rodenticide Act (FIFRA)
- Endangered Species Act (ESA)

- National Historic Preservation Act
- Archaelogical resources Protection Act (ARPA)
- Native American Graves Protection and Repatriation Act (NAGPRA)
- American Indian Religious Freedom Act
- DOE American Indian Policy

Supporting Knowledge and/or Skills

a. Describe the process for licensing applicators as defined in the Federal Insecticide, Fungicide, and Rodenticide Act (FIFRA).

b. Discuss the Endangered Species Act consultation requirements.

c. Discuss the key provisions of the National Historic Preservation Act and the American Indian Religious Freedom Act.

d. Discuss the Department's policy on American Indians.

21. LFRG personnel shall demonstrate a familiarity level knowledge of how environmental laws and regulations are enforced.

Supporting Knowledge and/or Skills

a. Discuss the interrelationship between the following:

- Environmental law
- The United States Code
- The Code of Federal Regulations
- State Laws and Regulations

b. Describe the organization, mission, and enforcement authorities of the Environmental Protection Agency (EPA) and applicable state regulatory agencies.

c. Discuss the role of the Department's legal counsel in Waste Management activities.

d. Discuss the enforcement of environmental statutes under civil and criminal authorities.

e. Discuss the potential liabilities of the Department and its contractors inherent in the enforcement of environmental regulations (i.e., compliance orders, enforcement actions, fines and penalties, and provisions for civil suits).

22. LFRG personnel shall demonstrate a familiarity level knowledge of the development, review, and assessment of the following Comprehensive Environmental Response, Compensation, and Liability Act documentation.

- Remedial Investigation Feasibility Study
- Investigative Work Plan Report
- Permits
- National Pollution Discharge Elimination System

- Record of Decision
- Remedial Design
- Remedial Work Plan
- Consent Order & Settlement Agreement

Supporting Knowledge and/or Skills

a. Describe the process for developing the listed documents.

b. Discuss the requirements for each document and describe the process for reviewing the listed documents.

c. Discuss the use of non-time critical removal action process as it applies to conducting decommissioning activities.

d. Discuss the purpose and scope of doing a CERCLA Crosswalk to DOE Order 435.1 requirements.

23. LFRG personnel shall demonstrate working level knowledge of hazardous waste as described in 40 CFR, Resource Conservation and Recovery Act.

Supporting Knowledge and/or Skills

a. Define the term "hazardous waste."

b. Using the decision tree in 40 CFR Part 260, relate RCRA solid waste to hazardous waste and identify the applicable RCRA regulations for each.

c. Identify the kinds of hazardous wastes generated within the Department and their sources.

d. Describe the combination of treatment, storage, and disposal facilities used to manage hazardous wastes.

e. Discuss the current methods of disposing of hazardous wastes.

f. For Resource Conservation and Recovery Act permitted facilities and interim status facilities discuss the following as required by 40 CFR 264 and 40 CFR 265:

- General facility standards
- Preparedness and prevention requirements
- Contingency plan and emergency procedures
- Manifest and record keeping requirements
- Releases from solid waste management units
- Closure requirements
- Use and management of containers
- Tank systems
- Landfills

g. Describe how to determine if a material is a solid waste. Given a material that is a solid

waste, describe how to determine if it is a hazardous or a mixed waste.

24. LFRG personnel shall demonstrate working level knowledge regarding DOE O450.1, Environmental protection program which requires implementation of an Environmental Management Systems approach integrated within an Integrated Safety Management System.

Supporting Knowledge and/or Skills

a. Discuss the general requirements of an environmental management system.

b. Discuss how the recommendations for a groundwater protection program from DOE G450.1-9, " Ground Water Protection Programs Implementation Guide for Use with DOE O 450.1, Environmental Protection Program" and DOE G450.1-6 "Ground Water Surveillance Monitoring Implementation Guide for Use with DOE O450.1,relate to the management of LLW and implementation of DOE M 435.1-1.

25. LFRG personnel shall demonstrate expert level knowledge of the management of low-level radioactive waste as described in DOE O 435.1, Radioactive Waste Management:

Supporting Knowledge and/or Skills

a. Define low-level waste.

b. Evaluate and determine the requirements for LLW management including mixed low-level, TSCA-Regulated, Accelerator-Produced, 11e.(2) and naturally occurring radioactive material waste.

c. Evaluate and determine the requirements for treatment, storage and disposal facility operations.

d. Discuss the Complex-wide Low-level Waste Management Program.

e. Review and evaluate the specific management controls included in the Radioactive Waste Management Basis.

f. Evaluate and determine the contingency actions for storage and transfer equipment.

g. Evaluate and determine the waste acceptance requirements for low-level waste.

h. Discuss life cycle planning and waste with no identified path to disposal as it relates to waste generation planning.

i. Evaluate and determine the minimum relevant information for characterizing low-level waste.

j. Discuss the waste certification program for low-level waste.

k. Discuss the packaging and transportation requirements for low-level waste.

l. Evaluate and determine the storage prohibitions for low-level waste.

m. Identify the types of data and records required to be retained as permanent records.

26. LFRG personnel shall demonstrate a working level knowledge of the management of transuranic waste as described in Department of Energy (DOE) Order 435.1, Radioactive Waste Management.

Supporting Knowledge and/or Skills

a. Define the term "transuranic waste" (TRU) including the requirements for classification of transuranic waste and the lower concentration limit below which transuranic waste may be considered low-level waste.

b. Evaluate and determine the requirements for management of transuranic, mixed transuranic and TSCA-Regulated waste.

c. Review and evaluate the site Radioactive Waste Management Basis.

d. Evaluate and determine the waste acceptance requirements for all transuranic waste storage, treatment, or disposal facilities.

e. Discuss life-cycle planning and waste with no identified path to disposal as it relates to waste generation planning.

f. Evaluate and determine the minimum relevant information for characterizing transuranic waste.

g. Discuss the waste certification program for transuranic waste.

h. Discuss the packaging and transportation requirements for transuranic waste.

i. Evaluate and determine the storage prohibitions for transuranic waste.

j. Evaluate and determine the monitoring requirements for transuranic waste facilities.

k. Identify the types of data and records required to be retained as permanent records.

27. LFRG personnel shall demonstrate a familiarity level knowledge of the management of High-Level Waste and/or other materials which, because of their highly radioactive nature, require similar handling as described in DOE Order 435.1, Radioactive Waste Management.

Supporting Knowledge and/or Skills

a. Define the term "high-level waste," and list potential sources of high-level waste from operations within the Complex.

b. Define "waste incidental to reprocessing" and explain how it is managed.

PA/CA Development

Groundwater

28. LFRG personnel shall demonstrate a working level knowledge of the Contaminate Transport

Supporting Knowledge and/or Skills

a. Describe the Advection Process
b. Describe the Diffusion and Dispersion Process
c. Explain the utilization of One, two and three dimensional modeling
d. Define the concept of sorption
e. Identify the factors influencing sorption and the effects on fate and transport of contaminants
f. Discuss the effects of pH on contaminant transport

29. LFRG personnel shall demonstrate a working level knowledge of the Flow and Transport in the Unsaturated Zone

Supporting Knowledge and/or Skills

a. Explain capillary action
b. Discuss soil-water characteristic curves
c. Discuss unsaturated hydraulic conductivity
d. Discuss the use of infiltration models
e. Explain the transport processes in the unsaturated zone
f. Discuss the importance of accurate distributive coefficients

30. LFRG personnel shall demonstrate a working level knowledge of the Numerical Modeling

Supporting Knowledge and/or Skills

a. Describe the purpose of numerical modeling
b. Discuss the use of conceptual models
c. Identify the source and types of errors associated with modeling
d. Discuss the fundamental differences between deterministic and probabilistic modeling
e. Discuss sensitivity analysis
f. Discuss uncertainty analysis

Air

31. LFRG personnel shall demonstrate a working level knowledge of the release of contaminants to the air phase.

Supporting Knowledge and/or Skills

a. Describe the mechanisms for transport of radionuclides from disposed waste to the air phase.

32. LFRG personnel shall demonstrate a working level knowledge of atmospheric transport and dispersion.

Supporting Knowledge and/or Skills

a. Describe atmospheric dispersion
b. Describe models utilized for atmospheric transport

Radon

33. LFRG personnel shall demonstrate an expert level knowledge in the Radon emanation.

Supporting Knowledge and/or Skills

a. Describe mechanisms that would hinder emanation of radon from disposed waste
b. Discuss gaseous diffusion in porous media

Intruder

34. LFRG personnel shall demonstrate a expert level knowledge in evaluating intruder scenarios.

Supporting Knowledge and/or Skills

a. Describe the following intruder scenarios: agriculture, construction, drilling
b. Describe the performance measures for acute and chronic exposure.

Institutional Controls

35. LFRG personnel shall demonstrate an expert level knowledge in institutional control requirements.

Supporting Knowledge and/or Skills

a. Discuss the importance of institutional controls, time of compliance, and justifications required for controls beyond the recommended time of compliance.
b. Describe the requirements for unrestricted access identified in DOE Order 5400.5, Radiation Protection of the Public and the Environment.
c. Discuss the implications of DOE P 454.1 and associated guidance to waste disposal operations
d. Specifically discuss how DOE 5400.5 and DOE P 454.1 could influence intruder assessments for a PA under DOE O 435.1 and point of compliance for the CA.

PA/CA Review

36. LFRG personnel shall demonstrate an expert level knowledge in the review of PA/CA's.

Supporting Knowledge and/or Skills

a. Demonstrate the ability to apply the requirements for developing and implementing the performance objective for PA/CA's identified in Chapter IV of DOE Manual/Guide 435.1-1.
b. Assists in the review of at least 1 PA/CA with other LFRG members.
c. Develop a Review Plan for review of at least 1 PA/CA.
d. Demonstrate the ability to apply the review criteria delineated in "LFRG Manual" for the following criteria: PA/CA Complete, PA/CA is Thorough and Technically Supported, and PA/CA Conclusions are Valid and Acceptable.
e. Describe the conditions that would require a revision to the PA/CA.
f. Describe the purpose and use of Special Analysis.

37. LFRG personnel shall demonstrate an expert level knowledge in the purpose and scope of the following documents: Disposal Authorization Statement; Annual Review; Maintenance Plan; Monitoring Plan; Closure Plan; Review Plan (PA/CA)

Supporting Knowledge and/or Skills

a. Describe the purpose and scope of the DAS, approval authority and what conditions require revision to the DAS
b. Describe the purpose and scope of the Annual Review Plan.
c. Describe the purpose and scope of the Maintenance Plan.
d. Describe the purpose and scope of the Monitoring Plan.
e. Describe the purpose and scope of the Closure Plan.
f. Describe the purpose and scope of the Review Plan for PA/CA's.

LFRG Operations

38. LFRG personnel shall demonstrate an expert level knowledge of LFRG Operations.

Supporting Knowledge and/or Skills

a. Discuss the LFRG Charter
b. Explain the purpose and use of the following LFRG procedures:
    1. Program Management Plan
    2. LFRG Manual
    3. Format and Content Guide for Disposal Facility PA and CA
    4. Maintenance Guide for Disposal Facility PA and CA
    5. Format and Content Guide for Disposal Facility Closure Plans
    6. Research and Development Implementation Plan

39. LFRG personnel shall demonstrate a familiarity level knowledge of the following as it relates to project management:

Supporting Knowledge and/or Skills

a. General Project Management
b. Leadership/Team Building
c. Scope Management
d. Communication Management
e. Cost Management
f. Time Management
g. Risk Management
h. Contract Management

REQUALIFICATION REQUIREMENTS

None.

Appendix F
Code of Federal Regulations, Title 40, Part 191

PART 191—ENVIRONMENTAL RADIATION PROTECTION STANDARDS FOR MANAGEMENT AND DISPOSAL OF SPENT NUCLEAR FUEL, HIGH-LEVEL AND TRANSURANIC RADIOACTIVE WASTES

Subpart A—Environmental Standards for Management and Storage

Sec.

Subpart B—Environmental Standards for Disposal

Subpart C—Environmental Standards for Ground-Water Protection

AUTHORITY: The Atomic Energy Act of 1954, as amended, 42 U.S.C. 2011–2296, Reorganization Plan No. 3 of 1970, 5 U.S.C. app. 1; the Nuclear Waste Policy Act of 1982, as amended, 42 U.S.C. 10101–10270, and the Waste Isolation Pilot Plant Land Withdrawal Act, Pub. L. 102–579, 106 Stat. 4777.

SOURCE: 50 FR 38084, Sept. 19, 1985, unless otherwise noted.

Subpart A—Environmental Standards for Management and Storage

§ 191.01 Applicability.

This subpart applies to:

(a) Radiation doses received by members of the public as a result of the management (except for transportation) and storage of spent nuclear fuel or high-level or transuranic radioactive wastes at any facility regulated by the Nuclear Regulatory Commission or by Agreement States, to the extent that such management and storage operations are not subject to the provisions of part 190 of title 40; and

(b) Radiation doses received by members of the public as a result of the management and storage of spent nuclear fuel or high-level or transuranic wastes at any disposal facility that is operated by the Department of Energy and that is not regulated by the Commission or by Agreement States.

§ 191.02 Definitions.

Unless otherwise indicated in this subpart, all terms shall have the same meaning as in Subpart A of Part 190.

(a) *Agency* means the Environmental Protection Agency.

(b) *Administrator* means the Administrator of the Environmental Protection Agency.

(c) *Commission* means the Nuclear Regulatory Commission.

(d) *Department* means the Department of Energy.

(e) *NWPA* means the Nuclear Waste Policy Act of 1982 (Pub. L. 97–425).

(f) *Agreement State* means any State with which the Commission or the Atomic Energy Commission has entered into an effective agreement under subsection 274b of the Atomic Energy Act of 1954, as amended (68 Stat. 919).

(g) *Spent nuclear fuel* means fuel that has been withdrawn from a nuclear reactor following irradiation, the constituent elements of which have not been separated by reprocessing.

(h) *High-level radioactive waste*, as used in this part, means high-level radioactive waste as defined in the Nuclear Waste Policy Act of 1982 (Pub. L. 97–425).

(i) *Transuranic radioactive waste*, as used in this part, means waste containing more than 100 nanocuries of alpha-emitting transuranic isotopes, with half-lives greater than twenty years, per gram of waste, except for: (1) High-level radioactive wastes; (2) wastes that the Department has determined, with the concurrence of the Administrator, do not need the degree of isolation required by this part; or (3) wastes that the Commission has approved for disposal on a case-by-case basis in accordance with 10 CFR Part 61.

(j) *Radioactive waste*, as used in this part, means the high-level and transuranic radioactive waste covered by this part.

(k) *Storage* means retention of spent nuclear fuel or radioactive wastes with the intent and capability to readily retrieve such fuel or waste for subsequent use, processing, or disposal.

(l) *Disposal* means permanent isolation of spent nuclear fuel or radioactive waste from the accessible environment with no intent of recovery, whether or not such isolation permits the recovery of such fuel or waste. For example, disposal of waste in a mined geologic repository occurs when all of the shafts to the repository are backfilled and sealed.

(m) *Management* means any activity, operation, or process (except for transportation) conducted to prepare spent nuclear fuel or radioactive waste for storage or disposal, or the activities associated with placing such fuel or waste in a disposal system.

(n) *Site* means an area contained within the boundary of a location under the effective control of persons possessing or using spent nuclear fuel or radioactive waste that are involved in any activity, operation, or process covered by this subpart.

(o) *General environment* means the total terrestrial, atmospheric, and aquatic environments outside sites within which any activity, operation, or process associated with the management and storage of spent nuclear fuel or radioactive waste is conducted.

(p) *Member of the public* means any individual except during the time when that individual is a worker engaged in any activity, operation, or process that is covered by the Atomic Energy Act of 1954, as amended.

(q) *Critical organ* means the most exposed human organ or tissue exclusive of the integumentary system (skin) and the cornea.

§ 191.03 Standards.

(a) Management and storage of spent nuclear fuel or high-level or transuranic radioactive wastes at all facilities regulated by the Commission or by Agreement States shall be conducted in such a manner as to provide reasonable assurance that the combined annual dose equivalent to any member of the public in the general environment resulting from: (1) Discharges of radioactive material and direct radiation from such management and storage and (2) all operations covered by Part 190; shall not exceed 25 millirems to the whole body, 75 millirems to the thyroid, and 25 millirems to any other critical organ.

(b) Management and storage of spent nuclear fuel or high-level or transuranic radioactive wastes at all facilities for the disposal of such fuel or waste that are operated by the Department and that are not regulated by the Commission or Agreement States shall be conducted in such a manner as to provide reasonable assurance that the combined annual dose equivalent to any member of the public in the general environment resulting from discharges of radioactive material and direct radiation from such management and storage shall not exceed 25 millirems to the whole body and 75 millirems to any critical organ.

§ 191.04 Alternative standards.

(a) The Administrator may issue alternative standards from those standards established in § 191.03(b) for waste management and storage activities at facilities that are not regulated by the Commission or Agreement States if, upon review of an application for such alternative standards:

(1) The Administrator determines that such alternative standards will prevent any member of the public from receiving a continuous exposure of more than 100 millirems per year dose equivalent and an infrequent exposure of more than 500 millirems dose equivalent in a year from all sources, excluding natural background and medical procedures; and

(2) The Administrator promptly makes a matter of public record the degree to which continued operation of the facility is expected to result in levels in excess of the standards specified in § 191.03(b).

(b) An application for alternative standards shall be submitted as soon as possible after the Department determines that continued operation of a facility will exceed the levels specified in § 191.03(b) and shall include all information necessary for the Administrator to make the determinations called for in § 191.04(a).

(c) Requests for alternative standards shall be submitted to the Administrator, U.S. Environmental Protection Agency, 1200 Pennsylvania Ave., NW., Washington, DC 20460.

[50 FR 38084, Sept. 19, 1985, as amended at 65 FR 47325, Aug. 2, 2000]

§ 191.05 Effective date.

The standards in this subpart shall be effective on November 18, 1985.

Subpart B—Environmental Standards for Disposal

§ 191.11 Applicability.

(a) This subpart applies to:

(1) Radioactive materials released into the accessible environment as a result of the disposal of spent nuclear fuel or high-level or transuranic radioactive wastes;

(2) Radiation doses received by members of the public as a result of such disposal; and

(3) Radioactive contamination of certain sources of ground water in the vicinity of disposal systems for such fuel or wastes.

(b) This subpart does not apply to:

(1) Disposal directly into the oceans or ocean sediments;

(2) Wastes disposed of before November 18, 1985; and

(3) The characterization, licensing, construction, operation, or closure of any site required to be characterized under section 113(a) of Public Law 97–425, 96 Stat. 2201.

[50 FR 38084, Sept. 19, 1985, as amended at 58 FR 66414, Dec. 20, 1993]

§ 191.12 Definitions.

Unless otherwise indicated in this subpart, all terms shall have the same meaning as in subpart A of this part.

Accessible environment means: (1) The atmosphere; (2) land surfaces; (3) surface waters; (4) oceans; and (5) all of the lithosphere that is beyond the controlled area.

Active institutional control means: (1) Controlling access to a disposal site by any means other than passive institutional controls; (2) performing maintenance operations or remedial actions at a site, (3) controlling or cleaning up releases from a site, or (4) monitoring parameters related to disposal system performance.

Annual committed effective dose means the committed effective dose resulting from one-year intake of radionuclides released plus the annual effective dose caused by direct radiation from facilities or activities subject to subparts B and C of this part.

Aquifer means an underground geological formation, group of formations, or part of a formation that is capable of yielding a significant amount of water to a well or spring.

Barrier means any material or structure that prevents or substantially delays movement of water or radionuclides toward the accessible environment. For example, a barrier may be a geologic structure, a canister, a waste form with physical and chemical characteristics that significantly decrease the mobility of radionuclides, or a material placed over and around waste, provided that the material or structure substantially delays movement of water or radionuclides.

Controlled area means: (1) A surface location, to be identified by passive institutional controls, that encompasses no more than 100 square kilometers and extends horizontally no more than five kilometers in any direction from the outer boundary of the original location of the radioactive wastes in a disposal system; and (2) the subsurface underlying such a surface location.

Disposal system means any combination of engineered and natural barriers that isolate spent nuclear fuel or radioactive waste after disposal.

Dose equivalent means the product of absorbed dose and appropriate factors to account for differences in biological effectiveness due to the quality of radiation and its spatial distribution in the body; the unit of dose equivalent is the "rem" ("sievert" in SI units).

Effective dose means the sum over specified tissues of the products of the dose equivalent received following an exposure of, or an intake of radionuclides into, specified tissues of the body, multiplied by appropriate weighting factors. This allows the various tissue-specific health risks to be summed into an overall health risk. The method used to calculate effective dose is described in appendix B of this part.

Ground water means water below the land surface in a zone of saturation.

Heavy metal means all uranium, plutonium, or thorium placed into a nuclear reactor.

Implementing agency means:

(1) The Commission for facilities licensed by the Commission;

(2) The Agency for those implementation responsibilities for the Waste Isolation Pilot Plant, under this part, given to the Agency by the Waste Isolation Pilot Plant Land Withdrawal Act (Pub. L. 102–579, 106 Stat. 4777) which, for the purposes of this part, are:

(i) Determinations by the Agency that the Waste Isolation Pilot Plant is in compliance with subpart A of this part;

(ii) Issuance of criteria for the certifications of compliance with subparts B and C of this part of the Waste Isolation Pilot Plant's compliance with subparts B and C of this part;

(iii) Certifications of compliance with subparts B and C of this part of

the Waste Isolation Pilot Plant's compliance with subparts B and C of this part:

(iv) If the initial certification is made, periodic recertification of the Waste Isolation Pilot Plant's continued compliance with subparts B and C of this part;

(v) Review and comment on performance assessment reports of the Waste Isolation Pilot Plant; and

(vi) Concurrence by the Agency with the Department's determination under § 191.02(i) that certain wastes do not need the degree of isolation required by subparts B and C of this part; and

(3) The Department of Energy for any other disposal facility and all other implementation responsibilities for the Waste Isolation Pilot Plant, under this part, not given to the Agency.

International System of Units is the version of the metric system which has been established by the International Bureau of Weights and Measures and is administered in the United States by the National Institute of Standards and Technology. The abbreviation for this system is "SI."

Lithosphere means the solid part of the Earth below the surface, including any ground water contained within it.

Passive institutional control means: (1) Permanent markers placed at a disposal site, (2) public records and archives, (3) government ownership and regulations regarding land or resource use, and (4) other methods of preserving knowledge about the location, design, and contents of a disposal system.

Performance assessment means an analysis that: (1) Identifies the processes and events that might affect the disposal system; (2) examines the effects of these processes and events on the performance of the disposal system; and (3) estimates the cumulative releases of radionuclides, considering the associated uncertainties, caused by all significant processes and events. These estimates shall be incorporated into an overall probability distribution of cumulative release to the extent practicable.

Radioactive material means matter composed of or containing radionuclides, with radiological half-lives greater than 20 years, subject to the Atomic Energy Act of 1954, as amended.

SI unit means a unit of measure in the International System of Units.

Sievert is the SI unit of effective dose and is equal to 100 rem or one joule per kilogram. The abbreviation is "Sv."

Undisturbed performance means the predicted behavior of a disposal system, including consideration of the uncertainties in predicted behavior, if the disposal system is not disrupted by human intrusion or the occurrence of unlikely natural events.

Waste, as used in this subpart, means any spent nuclear fuel or radioactive waste isolated in a disposal system.

Waste form means the materials comprising the radioactive components of waste and any encapsulating or stabilizing matrix.

[50 FR 38084, Sept. 19, 1985, as amended at 58 FR 66414, Dec. 20, 1993]

§ 191.13 Containment requirements.

(a) Disposal systems for spent nuclear fuel or high-level or transuranic radioactive wastes shall be designed to provide a reasonable expectation, based upon performance assessments, that the cumulative releases of radionuclides to the accessible environment for 10,000 years after disposal from all significant processes and events that may affect the disposal system shall:

(1) Have a likelihood of less than one chance in 10 of exceeding the quantities calculated according to Table 1 (appendix A); and

(2) Have a likelihood of less than one chance in 1,000 of exceeding ten times the quantities calculated according to Table 1 (appendix A).

(b) Performance assessments need not provide complete assurance that the requirements of § 191.13(a) will be met. Because of the long time period involved and the nature of the events and processes of interest, there will inevitably be substantial uncertainties in projecting disposal system performance. Proof of the future performance of a disposal system is not to be had in the ordinary sense of the word in situations that deal with much shorter time frames. Instead, what is required is a reasonable expectation, on the basis of the record before the implementing

agency, that compliance with §191.13 (a) will be achieved.

§ 191.14 Assurance requirements.

To provide the confidence needed for long-term compliance with the requirements of §191.13, disposal of spent nuclear fuel or high-level or transuranic wastes shall be conducted in accordance with the following provisions, except that these provisions do not apply to facilities regulated by the Commission (see 10 CFR Part 60 for comparable provisions applicable to facilities regulated by the Commission):

(a) Active institutional controls over disposal sites should be maintained for as long a period of time as is practicable after disposal; however, performance assessments that assess isolation of the wastes from the accessible environment shall not consider any contributions from active institutional controls for more than 100 years after disposal.

(b) Disposal systems shall be monitored after disposal to detect substantial and detrimental deviations from expected performance. This monitoring shall be done with techniques that do not jeopardize the isolation of the wastes and shall be conducted until there are no significant concerns to be addressed by further monitoring.

(c) Disposal sites shall be designated by the most permanent markers, records, and other passive institutional controls practicable to indicate the dangers of the wastes and their location.

(d) Disposal systems shall use different types of barriers to isolate the wastes from the accessible environment. Both engineered and natural barriers shall be included.

(e) Places where there has been mining for resources, or where there is a reasonable expectation of exploration for scarce or easily accessible resources, or where there is a significant concentration of any material that is not widely available from other sources, should be avoided in selecting disposal sites. Resources to be considered shall include minerals, petroleum or natural gas, valuable geologic formations, and ground waters that are either irreplaceable because there is no reasonable alternative source of drinking water available for substantial populations or that are vital to the preservation of unique and sensitive ecosystems. Such places shall not be used for disposal of the wastes covered by this part unless the favorable characteristics of such places compensate for their greater likelihood of being disturbed in the future.

(f) Disposal systems shall be selected so that removal of most of the wastes is not precluded for a reasonable period of time after disposal.

§ 191.15 Individual protection requirements.

(a) Disposal systems for waste and any associated radioactive material shall be designed to provide a reasonable expectation that, for 10,000 years after disposal, undisturbed performance of the disposal system shall not cause the annual committed effective dose, received through all potential pathways from the disposal system, to any member of the public in the accessible environment, to exceed 15 millirems (150 microsieverts).

(b) Annual committed effective doses shall be calculated in accordance with appendix B of this part.

(c) Compliance assessments need not provide complete assurance that the requirements of paragraph (a) of this section will be met. Because of the long time period involved and the nature of the processes and events of interest, there will inevitably be substantial uncertainties in projecting disposal system performance. Proof of the future performance of a disposal system is not to be had in the ordinary sense of the word in situations that deal with much shorter time frames. Instead, what is required is a reasonable expectation, on the basis of the record before the implementing agency, that compliance with paragraph (a) of this section will be achieved.

(d) Compliance with the provisions in this section does not negate the necessity to comply with any other applicable Federal regulations or requirements.

(e) The standards in this section shall be effective on January 19, 1994.

[58 FR 66414, Dec. 20, 1993]

§ 191.16 Alternative provisions for disposal.

The Administrator may, by rule, substitute for any of the provisions of subpart B alternative provisions chosen after:

(a) The alternative provisions have been proposed for public comment in the FEDERAL REGISTER together with information describing the costs, risks, and benefits of disposal in accordance with the alternative provisions and the reasons why compliance with the existing provisions of Subpart B appears inappropriate;

(b) A public comment period of at least 90 days has been completed, during which an opportunity for public hearings in affected areas of the country has been provided; and

(c) The public comments received have been fully considered in developing the final version of such alternative provisions.

[50 FR 38084, Sept. 19, 1985. Redesignated at 58 FR 66414, Dec. 20, 1993]

§ 191.17 Effective date.

The standards in this subpart shall be effective on November 18, 1985.

[50 FR 38084, Sept. 19, 1985, 50 FR 40009, Oct. 1, 1985. Redesignated at 58 FR 66414, Dec. 20, 1993]

Subpart C—Environmental Standards for Ground-Water Protection

SOURCE: 58 FR 66415, Dec. 20, 1993, unless otherwise noted.

§ 191.21 Applicability.

(a) This subpart applies to:

(1) Radiation doses received by members of the public as a result of activities subject to subpart B of this part; and

(2) Radioactive contamination of underground sources of drinking water in the accessible environment as a result of such activities.

(b) This subpart does not apply to:

(1) Disposal directly into the oceans or ocean sediments;

(2) Wastes disposed of before the effective date of this subpart; and

(3) The characterization, licensing, construction, operation, or closure of any site required to be characterized under section 113(a) of Public Law 97–425, 96 Stat. 2201.

§ 191.22 Definitions.

Unless otherwise indicated in this subpart, all terms have the same meaning as in subparts A and B of this part.

Public water system means a system for the provision to the public of piped water for human consumption, if such system has at least fifteen service connections or regularly serves at least twenty-five individuals. Such term includes:

(1) Any collection, treatment, storage, and distribution facilities under control of the operator of such system and used primarily in connection with such system; and

(2) Any collection or pretreatment storage facilities not under such control which are used primarily in connection with such system.

Total dissolved solids means the total dissolved (filterable) solids in water as determined by use of the method specified in 40 CFR part 136.

Underground source of drinking water means an aquifer or its portion which:

(1) Supplies any public water system; or

(2) Contains a sufficient quantity of ground water to supply a public water system; and

(i) Currently supplies drinking water for human consumption; or

(ii) Contains fewer than 10,000 milligrams of total dissolved solids per liter.

§ 191.23 General provisions.

(a) Determination of compliance with this subpart shall be based upon underground sources of drinking water which have been identified on the date the implementing agency determines compliance with subpart C of this part.

(b) [Reserved]

§ 191.24 Disposal standards.

(a) Disposal systems.

(1) *General.* Disposal systems for waste and any associated radioactive material shall be designed to provide a reasonable expectation that 10,000 years of undisturbed performance after disposal shall not cause the levels of radioactivity in any underground

§ 191.16 Alternative provisions for disposal.

The Administrator may, by rule, substitute for any of the provisions of subpart B alternative provisions chosen after:

(a) The alternative provisions have been proposed for public comment in the FEDERAL REGISTER together with information describing the costs, risks, and benefits of disposal in accordance with the alternative provisions and the reasons why compliance with the existing provisions of Subpart B appears inappropriate;

(b) A public comment period of at least 60 days has been completed, during which an opportunity for public hearings in affected areas of the country has been provided; and

(c) The public comments received have been fully considered in developing the final version of such alternative provisions.

[50 FR 38084, Sept. 19, 1985. Redesignated at 58 FR 66414, Dec. 20, 1993]

§ 191.17 Effective date.

The standards in this subpart shall be effective on November 18, 1985.

[50 FR 38084, Sept. 19, 1985, 50 FR 40006, Oct. 1, 1985. Redesignated at 58 FR 66414, Dec. 20, 1993]

Subpart C—Environmental Standards for Ground-Water Protection

SOURCE: 58 FR 66415, Dec. 20, 1993, unless otherwise noted.

§ 191.21 Applicability.

(a) This subpart applies to:

(1) Radiation doses received by members of the public as a result of activities subject to subpart B of this part; and

(2) Radioactive contamination of underground sources of drinking water in the accessible environment as a result of such activities.

(b) This subpart does not apply to:

(1) Disposal directly into the oceans or ocean sediments;

(2) Wastes disposed of before the effective date of this subpart; and

(3) The characterization, licensing, construction, operation, or closure of any site required to be characterized under section 113(a) of Public Law 97–425, 96 Stat. 2201.

§ 191.22 Definitions.

Unless otherwise indicated in this subpart, all terms have the same meaning as in subparts A and B of this part.

Public water system means a system for the provision to the public of piped water for human consumption, if such system has at least fifteen service connections or regularly serves at least twenty-five individuals. Such term includes:

(1) Any collection, treatment, storage, and distribution facilities under control of the operator of such system and used primarily in connection with such system; and

(2) Any collection or pretreatment storage facilities not under such control which are used primarily in connection with such system.

Total dissolved solids means the total dissolved (filterable) solids in water as determined by use of the method specified in 40 CFR part 136.

Underground source of drinking water means an aquifer or its portion which:

(1) Supplies any public water system; or

(2) Contains a sufficient quantity of ground water to supply a public water system, and

(i) Currently supplies drinking water for human consumption; or

(ii) Contains fewer than 10,000 milligrams of total dissolved solids per liter.

§ 191.23 General provisions.

(a) Determination of compliance with this subpart shall be based upon underground sources of drinking water which have been identified on the date the implementing agency determines compliance with subpart C of this part.

(b) [Reserved]

§ 191.24 Disposal standards.

(a) Disposal systems.

(1) *General.* Disposal systems for waste and any associated radioactive material shall be designed to provide a reasonable expectation that 10,000 years of undisturbed performance after disposal shall not cause the levels of radioactivity in any underground

source of drinking water, in the accessible environment, to exceed the limits specified in 40 CFR part 141 as they exist on January 19, 1994.

(2) *Disposal systems above or within a formation which within one-quarter (¼) mile contains an underground source of drinking water.* [Reserved]

(b) Compliance assessments need not provide complete assurance that the requirements of paragraph (a) of this section will be met. Because of the long time period involved and the nature of the processes and events of interest, there will inevitably be substantial uncertainties in projecting disposal system performance. Proof of the future performance of a disposal system is not to be had in the ordinary sense of the word in situations that deal with much shorter time frames. Instead, what is required is a reasonable expectation, on the basis of the record before the implementing agency, that compliance with paragraph (a) of this section will be achieved.

§ 191.25 Compliance with other Federal regulations.

Compliance with the provisions in this subpart does not negate the necessity to comply with any other applicable Federal regulations or requirements.

§ 191.26 Alternative provisions.

The Administrator may, by rule, substitute for any of the provisions of this subpart alternative provisions chosen after:

(a) The alternative provisions have been proposed for public comment in the FEDERAL REGISTER together with information describing the costs, risks, and benefits of disposal in accordance with the alternative provisions and the reasons why compliance with the existing provisions of this subpart appears inappropriate;

(b) A public comment period of at least 90 days has been completed, during which an opportunity for public hearings in affected areas of the country has been provided; and

(c) The public comments received have been fully considered in developing the final version of such alternative provisions.

§ 191.27 Effective date.

The standards in this subpart shall be effective on January 19, 1994.

APPENDIX A TO PART 191—TABLE FOR SUBPART B

TABLE 1—RELEASE LIMITS FOR CONTAINMENT REQUIREMENTS

[Cumulative releases to the accessible environment for 10,000 years after disposal]

Radionuclide	Release limit per 1,000 MTHM or other unit of waste (see notes) (curies)
Americium-241 or -243	100
Carbon-14	100
Cesium-135 or -137	1,000
Iodine-129	100
Neptunium-237	100
Plutonium-238, -239, -240, or -242	100
Radium-226	100
Strontium-90	1,000
Technetium-99	10,000
Thorium-230 or -232	10
Tin-126	1,000
Uranium-233, -234, -235, -236, or -238	100
Any other alpha-emitting radionuclide with a half-life greater than 20 years	100
Any other radionuclide with a half-life greater than 20 years that does not emit alpha particles	1,000

APPLICATION OF TABLE 1

NOTE 1: *Units of Waste.* The Release Limits in Table 1 apply to the amount of wastes in any one of the following:

(a) An amount of spent nuclear fuel containing 1,000 metric tons of heavy metal (MTHM) exposed to a burnup between 25,000 megawatt-days per metric ton of heavy metal (MWd/MTHM) and 40,000 MWd/MTHM;

(b) The high-level radioactive wastes generated from reprocessing each 1,000 MTHM exposed to a burnup between 25,000 MWd/MTHM and 40,000 MWd/MTHM;

(c) Each 100,000,000 curies of gamma or beta-emitting radionuclides with half-lives greater than 20 years but less than 100 years (for use as discussed in Note 5 or with materials that are identified by the Commission as high-level radioactive waste in accordance with part B of the definition of high-level waste in the NWPA);

(d) Each 1,000,000 curies of other radionuclides (i.e., gamma or beta-emitters with half-lives greater than 100 years or any alpha-emitters with half-lives greater than 20 years) (for use as discussed in Note 5 or with materials that are identified by the Commission as high-level radioactive waste in accordance with part B of the definition of high-level waste in the NWPA); or

(e) An amount of transuranic (TRU) wastes containing one million curies of alpha-emitting transuranic radionuclides with half-lives greater than 20 years.

NOTE 3: *Release Limits for Specific Disposal Systems.* To develop Release Limits for a particular disposal system, the quantities in Table 1 shall be adjusted for the amount of waste included in the disposal system compared to the various units of waste defined in Note 1. For example:

(a) If a particular disposal system contained the high-level wastes from 50,000 MTHM, the Release Limits for that system would be the quantities in Table 1 multiplied by 50 (50,000 MTHM divided by 1,000 MTHM).

(b) If a particular disposal system contained three million curies of alpha-emitting transuranic wastes, the Release Limits for that system would be the quantities in Table 1 multiplied by three (three million curies divided by one million curies).

(c) If a particular disposal system contained both the high-level wastes from 50,000 MTHM *and* 5 million curies of alpha-emitting transuranic wastes, the Release Limits for that system would be the quantities in Table 1 multiplied by 55:

$$\frac{50{,}000\,\text{MTHM}}{1{,}000\,\text{MTHM}} + \frac{5{,}000{,}000\,\text{curies TRU}}{1{,}000{,}000\,\text{curies TRU}} = 55$$

NOTE 3: *Adjustments for Reactor Fuels with Different Burnup.* For disposal systems containing reactor fuels (or the high-level wastes from reactor fuels) exposed to an average burnup of less than 25,000 MWd/MTHM or greater than 40,000 MWd/MTHM, the units of waste defined in (a) and (b) of Note 1 shall be adjusted. The unit shall be multiplied by the ratio of 30,000 MWd/MTHM divided by the fuel's actual average burnup, except that a value of 5,000 MWd/MTHM may be used when the average fuel burnup is below 5,000 MWd/MTHM and a value of 100,000 MWd/MTHM shall be used when the average fuel burnup is above 100,000 MWd/MTHM. This adjusted unit of waste shall then be used in determining the Release Limits for the disposal system.

For example, if a particular disposal system contained only high-level wastes with an average burnup of 3,000 MWd/MTHM, the unit of waste for that disposal system would be:

$$1{,}000\,\text{MTHM} \times \frac{(30{,}000)}{(5{,}000)} = 6{,}000\,\text{MTHM}$$

If that disposal system contained the high-level wastes from 60,000 MTHM (with an average burnup of 3,000 MWd/MTHM), then the Release Limits for that system would be the quantities in Table 1 multiplied by ten:

$$\frac{60{,}000\,\text{MTHM}}{6{,}000\,\text{MTHM}} = 10$$

which is the same as:

$$\frac{60{,}000\,\text{MTHM}}{1{,}000\,\text{MTHM}} \times \frac{(5{,}000\,\text{MWd/MTHM})}{(30{,}000\,\text{MWd/MTHM})} = 10$$

NOTE 4: *Treatment of Fractionated High-Level Wastes.* In some cases, a high-level waste stream from reprocessing spent nuclear fuel may have been (or will be) separated into two or more high-level waste components destined for different disposal systems. In such cases, the implementing agency may allocate the Release Limit multiplier (based upon the original MTHM and the average fuel burnup of the high-level waste stream) among the various disposal systems as it chooses, provided that the total Release Limit multiplier used for that waste stream at all of its disposal systems may not exceed the Release Limit multiplier that would be used if the entire waste stream were disposed of in one disposal system.

NOTE 5: *Treatment of Wastes with Poorly Known Burnups or Original MTHM.* In some cases, the records associated with particular high-level waste streams may not be adequate to accurately determine the original metric tons of heavy metal in the reactor fuel that created the waste, or to determine the average burnup that the fuel was exposed to. If the uncertainties are such that the original amount of heavy metal or the average fuel burnup for particular high-level waste streams cannot be quantified, the units of waste derived from (a) and (b) of Note 1 shall no longer be used. Instead, the units of waste defined in (c) and (d) of Note 1 shall be used for such high-level waste streams. If the uncertainties in such information allow a range of values to be associated with the original amount of heavy metal or the average fuel burnup, then the calculations described in previous Notes will be conducted using the values that result in the smallest Release Limits, except that the Release Limits need not be smaller than those that would be calculated using the units of waste defined in (c) and (d) of Note 1.

NOTE 6: *Uses of Release Limits to Determine Compliance with §191.13* Once release limits for a particular disposal system have been determined in accordance with Notes 1 through 5, these release limits shall be used to determine compliance with the requirements of §191.13 as follows. In cases where a mixture of radionuclides is projected to be released to the accessible environment, the limiting values shall be determined as follows: For each radionuclide in the mixture, determine the ratio between the cumulative release quantity projected over 10,000 years

and the limit for that radionuclide as determined from Table 1 and Notes 1 through 5. The sum of such ratios for all the radionuclides in the mixture may not exceed one with regard to §191.13(a)(1) and may not exceed ten with regard to §191.13(a)(2).

For example, if radionuclides A, B, and C are projected to be released in amounts Q_a, Q_b, and Q_c, and if the applicable Release Limits are RL_a, RL_b, and RL_c, then the cumulative releases over 10,000 years shall be limited so that the following relationship exists:

$$\frac{Q_a}{RL_a}+\frac{Q_b}{RL_b}+\frac{Q_c}{RL_c}\leq 1$$

[50 FR 38084, Sept. 19, 1985, as amended at 58 FR 66415, Dec. 20, 1993]

Appendix B to Part 191—Calculation of Annual Committed Effective Dose

I. Equivalent Dose

The calculation of the committed effective dose (CED) begins with the determination of the equivalent dose, H_T, to a tissue or organ, T, listed in Table B.2 below by using the equation:

$$H_T=\sum_R D_{T,R}\cdot w_R$$

where $D_{T,R}$ is the absorbed dose in rads (one gray, an SI unit, equals 100 rads) averaged over the tissue or organ, T, due to radiation type, R, and w_R is the radiation weighting factor which is given in Table B.1 below. The unit of equivalent dose is the rem (sievert, in SI units).

Table B.1—Radiation Weighting Factors, w_R[1]

Radiation type and energy range[2]	w_R value
Photons, all energies	1
Electrons and muons, all energies	1
Neutrons, energy < 10 keV	5
10 keV to 100 keV	10
>100 keV to 2 MeV	20
>2 MeV to 20 MeV	10
>20 MeV	5
Protons, other than recoil protons, >2 MeV	5
Alpha particles, fission fragments, heavy nuclei	20

[1] All values relate to the radiation incident on the body or, for internal sources, emitted from the source.
[2] See paragraph A14 in ICRP Publication 60 for the choice of values for other radiation types and energies not in the table.

II. Effective Dose

The next step is the calculation of the effective dose, E. The probability of occurrence of a stochastic effect in a tissue or organ is assumed to be proportional to the equivalent dose in the tissue or organ. The constant of proportionality differs for the various tissues of the body, but in assessing health detriment the total risk is required. This is taken into account using the tissue weighting factors, w_T in Table B.2, which represent the proportion of the stochastic risk resulting from irradiation of the tissue or organ to the total risk when the whole body is irradiated uniformly and H_T is the equivalent dose in the tissue or organ, T, in the equation:

$$E=\sum w_T\cdot H_T$$

Table B.2—Tissue Weighting Factors, W_T[1]

Tissue or organ	w_T value
Gonads	0.25
Breast	0.15
Red bone marrow	0.12
Lung	0.12
Thyroid	0.03
Bone surfaces	0.03
Remainder	[2]0.30

[1] The values are considered to be appropriate for protection for individuals of both sexes and all ages.
[2] For purposes of calculation, the remainder is comprised of the five tissues or organs not specifically listed in Table B.2 that receive the highest dose equivalents; a weighting factor of 0.06 is applied to each of them, including the various sections of the gastrointestinal tract which are treated as separate organs. This covers all tissues and organs except the hands and forearms, the feet and ankles, the skin and the lens of the eye. The excepted tissues and organs should be excluded from the computation of H_E.

III. Annual Committed Tissue or Organ Equivalent Dose

For internal irradiation from incorporated radionuclides, the total absorbed dose will be spread out in time, being gradually delivered as the radionuclide decays. The time distribution of the absorbed dose rate will vary with the radionuclide, its form, the mode of intake and the tissue within which it is incorporated. To take account of this distribution the quantity committed equivalent dose, $H_T(\tau)$ where is the integration time in years following an intake over any particular year, is used and is the integral over time of the equivalent dose rate in a particular tissue or organ that will be received by an individual following an intake of radioactive material into the body. The time period, τ, is taken as 50 years as an average time of exposure following intake:

$$H_T(\tau)=\int_{t_0}^{t_0+50} H_T(t)dt$$

for a single intake of activity at time t_0 where $H_T(t)$ is the relevant equivalent-dose rate in a tissue or organ at time t. For the purposes of this part, the previously mentioned single intake may be considered to be an annual intake.

IV. Annual Committed Effective Dose

If the committed equivalent doses to the individual tissues or organs resulting from an annual intake are multiplied by the appropriate weighting factors, w_T, and then summed, the result will be the annual committed effective dose, E(τ):

$$E(\tau) = \sum_T w_T \cdot H_T(\tau).$$

[58 FR 66415, Dec. 20, 1993]

APPENDIX C TO PART 191—GUIDANCE FOR IMPLEMENTATION OF SUBPART B

[NOTE: The supplemental information in this appendix is not an integral part of 40 CFR part 191. Therefore, the implementing agencies are not bound to follow this guidance. However, it is included because it describes the Agency's assumptions regarding the implementation of subpart B. This appendix will appear in the Code of Federal Regulations.]

The Agency believes that the implementing agencies must determine compliance with §§191.13, 191.15, and 191.16 of subpart B by evaluating long-term predictions of disposal system performance. Determining compliance with §191.13 will also involve predicting the likelihood of events and processes that may disturb the disposal system. In making these various predictions, it will be appropriate for the implementing agencies to make use of rather complex computational models, analytical theories, and prevalent expert judgment relevant to the numerical predictions. Substantial uncertainties are likely to be encountered in making these predictions. In fact, sole reliance on these numerical predictions to determine compliance may not be appropriate; the implementing agencies may choose to supplement such predictions with qualitative judgments as well. Because the procedures for determining compliance with subpart B have not been formulated and tested yet, this appendix to the rule indicates the Agency's assumptions regarding certain issues that may arise when implementing §§191.13, 191.15, and 191.16. Most of this guidance applies to any type of disposal system for the wastes covered by this rule. However, several sections apply only to disposal in mined geologic repositories and would be inappropriate for other types of disposal systems.

Consideration of Total Disposal System. When predicting disposal system performance, the Agency assumes that reasonable projections of the protection expected from all of the engineered and natural barriers of a disposal system will be considered. Portions of the disposal system should not be disregarded, even if projected performance is uncertain, except for portions of the system that make negligible contributions to the overall isolation provided by the disposal system.

Scope of Performance Assessments. Section 191.13 requires the implementing agencies to evaluate compliance through performance assessments as defined in §191.12(q). The Agency assumes that such performance assessments need not consider categories of events or processes that are estimated to have less than one chance in 10,000 of occurring over 10,000 years. Furthermore, the performance assessments need not evaluate in detail the releases from all events and processes estimated to have a greater likelihood of occurrence. Some of these events and processes may be omitted from the performance assessments if there is a reasonable expectation that the remaining probability distribution of cumulative releases would not be significantly changed by such omissions.

Compliance with §191.13. The Agency assumes that, whenever practicable, the implementing agency will assemble all of the results of the performance assessments to determine compliance with §191.13 into a "complementary cumulative distribution function" that indicates the probability of exceeding various levels of cumulative release. When the uncertainties in parameters are considered in a performance assessment, the effects of the uncertainties considered can be incorporated into a single such distribution function for each disposal system considered. The Agency assumes that a disposal system can be considered to be in compliance with §191.13 if this single distribution function meets the requirements of §191.13(a).

Compliance with §§191.15 and 191.16. When the uncertainties in undisturbed performance of a disposal system are considered, the implementing agencies need not require that a very large percentage of the range of estimated radiation exposures or radionuclide concentrations fall below limits established in §§191.15 and 191.16, respectively. The Agency assumes that compliance can be determined based upon "best estimate" predictions (e.g., the mean or the median of the appropriate distribution, whichever is higher).

Institutional Controls. To comply with §191.14(a), the implementing agency will assume that none of the active institutional controls prevent or reduce radionuclide releases for more than 100 years after disposal. However, the Federal Government is committed to retaining ownership of all disposal sites for spent nuclear fuel and high-level and transuranic radioactive wastes and will establish appropriate markers and records, consistent with §191.14(c). The Agency assumes that, as long as such passive institutional controls endure and are understood, they: (1) Can be effective in deterring systematic or persistent exploitation of these

disposal sites; and (2) can reduce the likelihood of inadvertent, intermittent human intrusion to a degree to be determined by the implementing agency. However, the Agency believes that passive institutional controls can never be assumed to eliminate the chance of inadvertent and intermittent human intrusion into these disposal sites.

Consideration of Inadvertent Human Intrusion into Geologic Repositories. The most speculative potential disruptions of a mined geologic repository are those associated with inadvertent human intrusion. Some types of intrusion would have virtually no effect on a repository's containment of waste. On the other hand, it is possible to conceive of intrusions (involving widespread societal loss of knowledge regarding radioactive wastes) that could result in major disruptions that no reasonable repository selection or design precautions could alleviate. The Agency believes that the most productive consideration of inadvertent intrusion concerns those realistic possibilities that may be usefully mitigated by repository design, site selection, or use of passive controls (although passive institutional controls should not be assumed to completely rule out the possibility of intrusion). Therefore, inadvertent and intermittent intrusion by exploratory drilling for resources (other than any provided by the disposal system itself) can be the most severe intrusion scenario assumed by the implementing agencies. Furthermore, the implementing agencies can assume that passive institutional controls or the intruders' own exploratory procedures are adequate for the intruders to soon detect, or be warned of, the incompatibility of the area with their activities.

Frequency and Severity of Inadvertent Human Intrusion into Geologic Repositories. The implementing agencies should consider the effects of each particular disposal system's site, design, and passive institutional controls in judging the likelihood and consequences of such inadvertent exploratory drilling. However, the Agency assumes that the likelihood of such inadvertent and intermittent drilling need not be taken to be greater than 30 boreholes per square kilometer of repository area per 10,000 years for geologic repositories in proximity to sedimentary rock formations, or more than 3 boreholes per square kilometer per 10,000 years for repositories in other geologic formations. Furthermore, the Agency assumes that the consequences of such inadvertent drilling need not be assumed to be more severe than: (1) Direct release to the land surface of all the ground water in the repository horizon that would promptly flow through the newly created borehole to the surface due to natural lithostatic pressure—or (if pumping would be required to raise water to the surface) release of 200 cubic meters of ground water pumped to the surface if that much water is readily available to be pumped; and (2) creation of a ground water flow path with a permeability typical of a borehole filled by the soil or gravel that would normally settle into an open hole over time—not the permeability of a carefully sealed borehole.

[50 FR 38084, Sept. 19, 1985. Redesignated and amended at 58 FR 66415, Dec. 20, 1993]

Appendix G
EH Guidance on Code of Federal Regulations, Title 40, Part 191

United States Government

Department of Energy

memorandum

DATE: August 6, 1999

REPLY TO ATTN OF: Air, Water and Radiation Division (EH-412)

SUBJECT: Performance Assessment for Greater Confinement Disposal of Transuranic Waste at the Nevada Test Site

TO: Carl Gertz
Assistant Manager for
Environmental Management
Nevada Operations Office

Mark W. Frei
Acting Associate Deputy Assistant
Secretary for Waste Management
Environmental Management

At the request of the Nevada Operations Office (NVO), we have prepared guidance for preparation of a performance assessment (PA) for closure of a greater confinement disposal (GCD) facility for transuranic (TRU) waste in the Area 5 Radioactive Waste Management Site (RWMS) at the Nevada Test Site (NTS). The guidance (see attachment) has been prepared based on our general oversight authority as well as our specific authority, along with EM-30, under Section II.2.b of DOE 5820.2A (Section I.2.E.1 of M 435.1-1) to approve disposal of TRU waste by disposal methods other than the Waste Isolation Pilot Plant. The guidance is consistent with that guidance provided verbally by EH-412 staff at meetings held in Las Vegas in November 1998. Drafts of the guidance were provided to NVO and EM-30 personnel.

The attached guidance pertains to the applicable version of 40 CFR 191 to consider for the PA, the use of appropriate dose assessment methodology, the scope of waste to be considered, consideration of inadvertent intrusion, and the Part 191 assurance requirements:

Based on the rulemaking record, EPA has "grandfathered" the GCD facility to the 1985 version of Part 191. Although use of the 1985 version is thus permissible for purposes of compliance, NVO should consider the 1993 version to be relevant for purposes of information and comparison.

We also recommend that the analysis include a calculation of individual doses in terms of effective dose equivalent, using DOE-approved dose conversion factors (Federal Guidance Reports Numbers 11 and 12). Furthermore, the analysis should consider all waste (including high activity low-level waste) in the four GCD boreholes that contain TRU waste.

For inadvertent intrusion, NVO should consider the site-specific effects of the disposal system's environmental and design attributes, local customs and construction practices, and institutional controls when determining intrusion scenarios and judging the consequences and likelihood of intrusion. Reasonable limits should be placed on the severity of the assumptions used to select intrusion scenarios and their frequencies. The scope and probability of intrusion events should be largely based on informed judgement. Our interpretation of published EPA guidance (Appendix C of current 40 CFR 191) for the GCD boreholes is included with our guidance.

Finally, the starting point for the 100-year analytical limit on active institutional controls (40 CFR 191.14(a)) should be assumed to occur immediately after disposal system closure -- i.e. when all planned engineered barriers have been installed that are expected to significantly stabilize the disposal configuration or to minimize disturbances by human or natural processes. Additional information is contained in the attachment. Please contact us if you have questions about our recommendations.

/s/

Raymond P. Berube
Deputy Assistant Secretary
for Environment
Office of Environment, Safety
and Health

Attachment

Office of Environmental Policy and Assistance Guidance on Preparation of a Performance Assessment Pursuant to 40 CFR 191 for Greater Confinement Disposal at the Nevada Test Site

Background

The Area 5 Radioactive Waste Management Site (RWMS) currently covers 91 acres and has been used since 1961 for disposal of low-level (LLW) and mixed low-level radioactive waste in a variety of pits, trenches, and greater confinement disposal (GCD) boreholes. Starting in 1984 and continuing through 1987, mixed TRU waste (mostly in the form of classified accident debris from nuclear weapons) was placed in four GCD boreholes, along with high-activity LLW principally containing Cs-137.[1] The four boreholes have been backfilled and operationally closed. By 2008, NVO plans to place a final cover over the current pits, trenches, and boreholes. At the same time, NVO will extend LLW and mixed LLW disposal operations to the contiguous north of the existing 91 acres, and within the confines of a series of berms placed to protect the disposal area from flooding. NVO expects that closure of the entire disposal area would occur about 2070.

NVO is preparing a series of documents to address waste management activities at the Area 5 RWMS. NVO has prepared a performance assessment (PA) to address LLW that had been emplaced in the Area 5 RMWS since September 1988, as well as a composite analysis (CA) that addresses radioactive material (including other waste disposed at the Area 5 RWMS) that may interact with the LLW addressed in the LLW PA. In addition, NVO is preparing a PA that specifically addresses the TRU waste in the four boreholes. The intent of this latter PA is to demonstrate compliance with 40 CFR 191, EPA's "Environmental Standards for the Management and Disposal of Spent Nuclear Fuel, High-Level and Transuranic Radioactive Wastes."

When EPA originally promulgated 10 CFR 191 in 1985, EPA justified the achievability of the standard in terms of an analysis that solely considered disposal of waste in mined geologic repositories, assuming placement of waste at a disposal horizon of about 1500 feet below the surface of the earth. Nonetheless, EPA applied the standard to any disposal method

[1] TRU waste was emplaced, and boreholes backfilled, in Boreholes 1 through 3 during 1984. TRU and high-activity low-level waste was emplaced in Borehole 4 during 1985 through 1987. Backfilling and operational closure occurred for Borehole 4 during 1987. Waste was placed in all four boreholes to within about 70 of the earth's surface.

other than disposal directly into the oceans or ocean sediments.

The standard included the criteria discussed below (compliance with the first three criteria would be demonstrated by performance assessment):

- **Containment criterion** - a limit on total quantity of particular radionuclides released into the accessible environment over 10,000 years following waste disposal;
- **Individual protection criterion** - an annual dose limit (25 to whole body and 75 mrem to any organ) for individuals in the accessible environment over 1000 years following waste disposal;
- **Groundwater protection criterion** - compliance with drinking water MCLs in any "special source of drinking water"[12] within the controlled area of the repository, over 1000 years following waste disposal; and
- **Assurance requirements** - Qualitative requirements pertaining to use of active and passive institutional controls, monitoring, resource avoidance, and so forth.

In addition, EPA published, as Appendix A to the standard, a table listing activity release limits for radionuclides subject to the containment criteria. Release limits are provided in terms of activity released over 10,000 per unit of either high-level waste (HLW), TRU waste, or spent nuclear fuel (SNF). EPA also published, as Appendix B to the standard, guidance on implementing the standard (i.e., guidance for preparing PAs). Although some of this guidance pertains to any disposal method covered by the standard, some applies only to a geologic repository.

The standard is applicable to waste disposed after 19 September 1985 (40 CFR 191.18). EPA's stated intent was to exclude coverage of TRU wastes that were disposed before DOE procedures for TRU waste management were adopted in 1970.[13]

Portions of the standard were later remanded by decision of the First U.S. Court of Appeals. The current version of the

[12] A "special source of drinking water" is defined in a way that excludes the groundwater under the GCD boreholes from consideration. Therefore, the groundwater protection criteria in the 1985 version of 40 CFR 191 would not be applicable to the TRU waste boreholes.

[13] "Some transuranic wastes produced in support of national defense programs were disposed of before the current DOE procedures for transuranic waste management in 1970. The exclusion of wastes already disposed of applies to these transuranic wastes, for which selection of disposal system sites, designs, and operational techniques are no longer options" [19 September 1985; 50 FR 38070].

standard, which EPA re-promulgated in 1993, contains requirements that are more stringent than those issued in 1985. In particular, EPA made the following changes to the standard's individual protection and groundwater protection criteria:

- **Individual protection** - Changed the dose limit to 15 mrem (ede) in a year, and extended the analytical time of compliance to 10,000 years;
- **Groundwater protection** - Made the criteria generally applicable to any underground source of drinking water, moved the point of compliance to the accessible environment, and extended the analytical time of compliance to 10,000 years.

Furthermore, EPA modified the standard to indicate that the individual and groundwater protection criteria apply to all waste in a disposal system -- in the event, for example, that commercial GTCC waste was disposed with HLW in a geologic repository. EPA stated that this change was merely a matter of clarification.[4] No changes were made to the containment criterion, Appendix A, or the implementation guidance (except that this guidance was reissued as Appendix C of 40 CFR 191).

The groundwater protection standard is applicable to waste disposed after 19 January 1994 (40 CFR 191.27).

When promulgating the 1993 version of the standard, and in response to DOE comments on the proposed rule, EPA indicated that DOE could assume the 1985 version of the standard would be applicable to the GCD boreholes containing TRU waste. Because borehole disposal began about the time of publication of the 1985 version of the rule, EPA in 1993 "grandfathered" the boreholes to the 1985 version of the rule.[5]

[4] See p. 2-25 of U.S.EPA, "High-Level and Transuranic Radioactive Wastes, Response to Comments for Amendments to 40 CFR Part 191," EPA 402-R-93-072, December 1993.

[5] "...The Agency believes that it is reasonable, due to the design nature of the...standards, that the standards which were in existence from 1985 until the First Circuit decision in 1987 (17 July 1987) are appropriate to be used for activities which occurred, or were begun, during that time rather than imposing new and different standards on such activities. ...Disposal which occurred on or after November 18, 1985 until the effective date of today's action is subject to the standards as they existed on November 19, 1985." (20 December 1993; 58 FR 66412) "EPA informed [DOE], prior to the first Circuit decision in 1987, that the 1985 version of part 191 was applicable to any disposal

Guidance

Guidance is provided on the following issues: (1) the applicable version of 40 CFR 191 to consider for the PA, (2) the use of appropriate internal dose assessment methodology, (3) the scope of waste to be considered in the PA, (4) consideration of inadvertent intrusion, and (5) the interpretation of "disposal" with respect to the Part 191 assurance requirements.

Applicable version of 40 CFR 191. Given EPA's statements in the rulemaking record, NVO may consider the 1985 version of 40 CFR 191 to be the applicable version of the standard. Nonetheless, NVO should consider the requirements in the 1993 version to be relevant. NVO should include an analysis in the PA that compares the projected performance of the four TRU waste boreholes against it. Such an analysis would not be for strict purposes of regulatory compliance but for purposes of information and comparison.

We recommend this action for the following reasons:

- Because the 1993 version of the standard is more stringent than the 1985 version, increased acceptance of the borehole disposal system may result if a case can be made that compliance with the more stringent standard is likely.
- This action would provide more information than would an analysis that considers compliance with the 1985 version alone. For example, although the groundwater protection criteria as stated in the 1985 version of the standard is of no practical application to the GCD boreholes, [4] there is interest in obtaining information about the groundwater pathway.
- This action would minimize possible objections to the

activities at the Greater Confinement Disposal (GCD) Facility. Therefore, any radioactive waste that was disposed at the GCD Facility is subject to all of the requirements of 40 CFR part 191 promulgated in 1985, and neither the First Circuit decision, the WIPP LWA, nor today's promulgation of revised regulations change that determination" [20 December 1993; 58 FR 66413].

[4] A special source of ground water means "Class I ground waters...that (1) are within the controlled area encompassing a disposal system or are less than five kilometers beyond the controlled area; (2) are supplying drinking water for thousands of persons as of the date that the Department chooses a location within that area for detailed characterization...; and (3) are irreplaceable in that no reasonable alternative source of drinking water is available to that population" [191.12(o)]. Conditions are unmet for groundwater beneath the Area 5 RMWS (e.g., clearly not condition 2 and arguably not condition 3).

analysis based on different possible interpretations of "disposal" as this term is defined in 40 CFR 191 (see below).

- This action would minimize possible technical objections regarding use of outdated internal dose methodology (see below).

Use of appropriate internal dose assessment methodology. The individual protection criteria in the 1985 version of the standard are in units of dose to critical organs. This older dose methodology has been largely replaced in the US by a newer effective dose system.

We understand that for the PA, internal doses to critical organs are being calculated using dose conversion factors derived from ICRP-2 models. Although the rationale for doing so is understandable, we believe that presentation of results using this system would be likely to result in technical objections which would detract from the analysis, whatever its other merits. To avoid such objections, and to help a reviewer to concentrate on relevant issues, we recommend adding to the analysis an assessment that provides results in terms of effective dose equivalent, using DOE-approved dose conversion factors (i.e., from Federal Guidance Reports Numbers 11 and 12). This recommendation is consistent with our recommendation about the relevancy of the 1993 version of Part 191.

Scope of the waste to be considered in the PA. For purposes of analysis, the PA should address all waste in the four TRU waste boreholes. That is, the PA should consider waste emplaced in the ground before 19 September 1985 (the first three of the four boreholes), as well as any high activity LLW placed with the TRU waste in Borehole 4. We make this recommendation because:

- This action would provide more information than a more restrictive analysis, including information necessary to assess the potential for long-term compliance with other applicable DOE requirements.
- It would minimize possible objections to the analysis based on different possible interpretations of "disposal" as this term is defined in 40 CFR 191 (see below).
- It would be consistent with EPA's position in the 1993 rulemaking record that the change in wording for the individual and groundwater protection criteria to consider all waste within a disposal system was merely a matter of clarification (i.e., applicable under the 1985 as well as the 1993 versions of the standard).

Therefore, for purposes of the PA, NVO should consider all waste in all four boreholes for purposes of compliance with the individual and groundwater protection criteria, but just the TRU waste within the four boreholes for purposes of compliance with

the containment criterion.[*] The PA need not address waste other than that within the four boreholes.

Consideration of inadvertent intrusion. Compliance with 40 CFR 191.13 requires an analysis of the consequences and probabilities of inadvertent intrusion into the disposal system. As a general principle, NVO should consider the site-specific effects of the disposal system's environmental and design attributes, local (or regional, if appropriate) customs or construction practices (including well-drilling practices), and passive institutional controls when determining intrusion scenarios and when judging the consequences and likelihood of these scenarios. The disposal system should be justified on its own site-specific merits based on common-sense analyses and rationale.

In making this recommendation, we recognize, as did EPA when it promulgated Part 191, that it is possible to hypothesize intruder scenarios so severe that no conceivable disposal system could be shown to meet the standards. That is, regardless of the site selection criteria or design precautions, it will always be possible to concoct an intrusion event that can be hypothesized to release contaminants in excess of requirements. Accordingly, we recommend that NVO's selection of intruder scenarios be guided by reason -- that reasonable limits be placed on the severity of the assumptions used to make the assessment. In so saying, we are guided by the belief that inadvertent intrusion is an hypothetical construction -- it can never be proved nor disproved. The most productive consideration of inadvertent intrusion for closure of the TRU waste boreholes concerns those realistic possibilities that may be usefully mitigated by disposal system location or design, or passive institutional controls. And, because we believe that it is impossible to develop a "correct" estimate of the scope and probability of any intrusion, that such an assessment needs to be largely based on informed judgement.

In Attachment 3 to this guidance, we have provided additional recommendations on interpretation of published EPA guidance (Appendix C of existing Part 191) for purposes of the GCD boreholes. This interpretation is necessary because some portions of the EPA guidance are meant to apply to geologic repositories, and therefore special consideration is needed for

[*] Unlike the individual and groundwater protection criteria, the containment criterion is expressed in terms of units of waste. Because the only waste units provided in Appendix A of the standard are for HLW, TRU waste, and SNF, there is no requirement in Part 191 to consider the LLW in Borehole 4 for purposes of the containment criterion.

application of these portions to the GCD boreholes.

Interpretation of "disposal" with respect to assurance requirements. The Part 191 assurance requirements call for certain activities that are affected by the timing of waste disposal. Significantly, EPA requires that "performance assessments that assess isolation of the wastes from the accessible environment shall not consider any contributions from active institutional controls for more than 100 years after disposal" [40 CFR 191.14(a)]. Monitoring and recoverability requirements are also imposed that are timed to take effect after disposal has occurred [40 CFR 191.14(b) & (f)]. To comply with these requirements, one must define when disposal is assumed to occur during the lifetime of the disposal facility.

Our review of the standard and rulemaking record suggests that, for purposes of borehole disposal at NTS, the definition of "disposal" in Part 191[7] can be interpreted in more than one way. We believe that this situation exists because although Part 191 applies to any land-based disposal system, it was written by EPA under the assumption that it would be primarily applied to waste disposal in a mined geologic repository located several hundred meters below ground.

Nonetheless, our judgement is that for purposes of analysis of NTS borehole disposal in compliance with 40 CFR 191.14(a), the 100-year active institutional control period should be assumed to begin immediately after disposal system closure.[8] NVO should assume that closure would occur when all planned engineered barriers have been installed, including final disposal unit covers, surface water control features, or other engineered features intended to stabilize the disposal facility or to minimize disturbance by human or natural processes.

This interpretation of 40 CFR 191.14 is reasonable considering the derivation of the Part 191 and 10 CFR 60 requirements in accordance with the regulatory process envisioned by Congress for the NWPA. It is practical and realistic considering that

[7] "Disposal" means permanent isolation of spent nuclear fuel or radioactive waste from the accessible environment with no intent of recovery, whether or not such isolation permits the recovery of such fuel or waste. For example, disposal of waste in a mined geologic repository occurs when all of the shafts to the repository are backfilled and sealed" [40 CFR 191.02].

[8] This analytical assumption, of course, doesn't call for a literal end to active institutional controls after 100 years or any other time period. In reality, access control and other active institutional control measures must continue at the Area 5 RWMS in accordance with DOE 5400.5 and 40 CFR 191.14(a).

the TRU waste boreholes are located in an area where disposal of LLW and mixed LLW has taken place, and will likely to continue to take place for many years. It is consistent with the approach used for performance assessments performed by DOE for LLW disposal facilities and by NRC for commercial LLW disposal facilities. (See Attachment 2.)

This interpretation, however, possibly leads to two additional issues: (1) the scope of waste to be considered for the analysis, and (2) the version of Part 191 to consider. If disposal was construed to occur at the time of waste emplacement and backfilling, then it could be argued that the 1985 version of the standard would be applicable, and to only one of the four boreholes. Conversely, if disposal was presumed to occur at the time of disposal facility closure, then it could be argued that the 1993 version of the standard would be applicable, and to all four boreholes. Without addressing the merits and demerits of either argument, we believe that these issues are mooted because of the other recommendations in this guidance (e.g., to consider all waste in all four boreholes, and to consider the 1985 version of the standard to be applicable for purposes of compliance and the 1993 version of the standard to be relevant for purposes of information and comparison).

Should the GCD Boreholes Be Considered a Type of Geologic Repository?

Although 40 CFR 191 does not define a mined geologic repository, the commonly understood characteristics of mined geologic repositories are significantly different from those of the GCD boreholes at NTS. Among other things we observe:

- In a generic environmental impact statement (GEIS) published in October 1980, DOE considered a variety of possible methods for disposal of commercially-generated high-level and transuranic waste (DOE/EIS-0046F). In this GEIS, and in the record of decision (ROD) published on 14 May 1981 (46 FR 26677), DOE adopted a strategy for development of conventionally-mined geologic repositories for disposal of such waste. In the GEIS, DOE described such a repository as, among other things, involving waste emplacement ranging from 600 to 1000 meters below the earth's surface. The geologic repository would be constructed using a room-and-pillar method and have an underground area of about 800 hectares (2000 acres). DOE distinguished a mined geologic repository from other possible disposal methods including very deep holes (boreholes where waste is placed at depths of as much as 6 miles), disposal by melting into continental ice sheets, transmutation, and space disposal.

- The Nuclear Waste Policy Act of 1982 (NWPA) was enacted to provide for the development of repositories for the disposal of high-level radioactive waste and spent nuclear fuel. The NWPA defines a "repository" as any system licensed by the Commission that is intended to be used for, or may be used for, the permanent **deep** geologic disposal of high-level radioactive waste and spent nuclear fuel..." [emphasis added]. Legislative history for this Act (P.L. 97-425) includes House Report No. 97-491 (the House bill was passed in lieu of the Senate bill) which describes the House's vision of a geologic repository. Artist's concepts and discussion picture a underground waste emplacement system covering about 2000 acres of underground rock and located about one-half mile (about 600 meters) underground. (The envisioned facility is similar to that identified by DOE in its GEIS.)

  The House Report also provides guidance for repository site selection by DOE pursuant to Section 112(a) of the Statute. (Section 112(a) requires that DOE develop guidelines to be used in selecting sites qualified to merit in-depth study

as possible repository sites.) Among other things the House Report states that "the primary feature of the site specifically to be evaluated consists of a rock medium about 1000 or more feet underground which will of itself provide one of the primary containments of the waste."

The NWPA provided an important statutory mandate for DOE's development of repository siting guidelines in 10 CFR 960, NRC's development of licensing regulations for geologic repositories for HLW and spent nuclear fuel in 10 CFR 60, and EPA's environmental standards in 40 CFR 191.

DOE's regulation 10 CFR 960, "General Guidelines for the Recommendation of Nuclear Waste Repositories," was issued in response to the NWPA. It defines a geologic repository as a "system, requiring licensing by the NRC, that is intended to be used for, the disposal of radioactive waste in excavated media.." This regulation indicates that a favorable siting condition for a geologic repository is one where waste emplacement would occur at least 300 meters below the surface of the earth. It disqualifies candidate sites if "site conditions do not allow all portions of the underground facility to be situated at least 200 meters below the directly overlying ground surface." (See 10 CFR 960.4-2-5(b)(1) and (d).)

NRC's regulation, 10 CFR 60, "Disposal of High-Level Waste in Geologic Repositories," was also issued in response to the NWPA. It defines a geologic repository as a "system which is intended to be used for, or may be used for, the disposal of radioactive wastes in excavated geologic media..." The regulation describes a favorable condition for a geologic repository as being one where waste would be emplaced at least 300 meters below the surface of the earth. (See 10 CFR 60.122(b)(5).)

From 1987 to 1989, NRC conducted a rulemaking intended originally to provide a more precise definition of high-level waste than that provided in the NWPA. In an Advance Notice of Proposed Rulemaking, NRC postulated that high-level waste might be defined numerically by evaluating the disposal capabilities of alternative disposal facilities that would be "less secure" than a geologic repository. NRC postulated that less secure facilities might make use of "intermediate depth burial or various engineering measures...to accommodate wastes with radionuclide concentrations unsuitable for disposal by shallow land burial" (27 February 1987; 52 FR 5995). NRC subsequently abandoned this effort; instead, it amended 10 CFR 61 to

require disposal of greater-than-Class C (GTCC) LLW [1] into a geologic repository as defined in 10 CFR 60 or by another disposal method approved by the Commission. NRC considered that other disposal methods could include intermediate disposal methods such as deep-augured holes or an intermediate depth repository [25 May 1989; 54 FR 22579]. NRC distinguished such intermediate disposal methods from a geologic repository (e.g., see 54 FR 22531). In support of the rulemaking, NRC pointedly referenced a report by the Congressional Office of Technology Assessment (OTA) that specifically cited the NTS boreholes as a type of intermediate disposal method. [2]

- EPA's standard, 40 CFR 191, was written to apply to disposal of HLW, spent nuclear fuel, and TRU waste under the NWPA and other statutes. Unlike either 10 CFR 60 or 10 CFR 960, it is applicable to any disposal method other than Yucca Mountain and disposal directly into the oceans or ocean sediments. Although the standard refers to mined geologic repositories in the definition of "disposal" and in guidance (see Appendix C of the current standard), [3] nowhere is either a geologic repository or a mined geologic repository defined. Nonetheless, material accompanying the development of these standards indicates that EPA's understanding of a "geologic repository" was consistent with NRC's, DOE's, and Congress's understanding of the term. [4] Illustrative material is provided below:

  For the 1985 version of the standard, EPA prepared a series of analyses that addressed model geologic repositories in salt, granite, and other media. For the proposed standard, the model geologic repositories were all characterized by

[1] For alpha-emitting transuranic isotopes having half-lives exceeding 5 years, the Part 61 Class C limit is 100 nCi/g. The Part 61 Class C limit for transuranic isotopes is thus similar to the definition of transuranic waste in 40 CFR 191.

[2] U.S. Congress, Office of Technology Assessment, "An Evaluation of Options for Managing Greater than Class C Low Level Radioactive Waste," OTA-BP-O-50, October 1988.

[3] The guidance refers, apparently interchangeably, to both "geologic repositories" and "mined geologic repositories."

[4] In the rulemaking record, EPA refers interchangeably to a "mined geologic repository," a "mined repository," and a "geologic repository."

emplacement at depths of about 1500 feet.[14] For the final 1985 standard, EPA included additional analyses that were intended to more closely mimic some of the sites selected by DOE under the NWPA for nomination as potential sites for the first repository. These sites included two bedded salt formations, a basalt formation, and unsaturated volcanic tuff formations at Yucca Mountain. EPA also examined two granite formations.[15]

For the 1993 version of the rule, EPA's analyses again considered only mined geologic repositories to justify the rule's achievability. However, for the 1993 standard EPA focused on disposal of TRU waste rather than HLW or spent nuclear fuel. As described in EPA's Background Information Document (BID), the modeled disposal system was based on national plans to develop geologic repositories consisting of "underground mines or excavations with working levels between 300 and 1,000 meters below the surface."[16] Waste would be "stacked in mined waste disposal rooms," and after waste emplacement the disposal facility "would be backfilled" and the "shafts and boreholes which connect the disposal facility to the surface would be backfilled and sealed."[17] The BID also briefly described the NTS GCD Test program as a project intended to demonstrate the feasibility of "greater depth" burial in alluvial sediments. The phrase, "intermediate depth," was also used to describe the boreholes.[18] The BID description of the GCD boreholes differs significantly from that for the modeled geologic repository.

Otherwise, in the proposed rule for the 1985 standard (29

[14] e.g., Smith, C.B., "Population Risks From Disposal of High-Level Radioactive Wastes in Geologic Repositories," EPA 520/3-80-006, Environmental Protection Agency, December 1982.

[15] U.S. Environmental Protection Agency, "High-Level and Transuranic Radioactive Wastes, Background Information Document for Final Rule," EPA 520/1-85-023, August 1985.

[16] U.S. Environmental Protection Agency, "Background Information Document for Proposed Amendments to 40 CFR 191, Environmental Standards for the Management and Disposal of Spent Nuclear Fuel, High-Level and Transuranic Radioactive Wastes," EPA 402-R-93-007, January 1993.

[17] Ibid.

[18] Ibid.

December 1982), EPA announced that it focused on geologic repositories because there was "more information available on this approach on than on other disposal methods, and because DOE has decided to focus the national program on this method (46 FR 26677)"[19] [47 FR 58198-9]. In the final rule for the 1985 standard (19 September 1985), EPA distinguishes between mined geologic repositories and other disposal methods (e.g., 50 FR 38070 and 38974), and contrasts a mined geologic repository with a surface disposal site [50 FR 38080].

Finally, in the final rule for the revised standard (20 December 1993), EPA concludes that disposal of solid radioactive waste into a geologic repository does not constitute underground injection within the context of the Safe Drinking Water Act. EPA does not define a geologic repository but cites the WIPP facility as an example of one [58 FR 66409-66411].

- Documents published in support of the GCD boreholes have described them as "intermediate depth" disposal.[20]

Conclusion. Statutory and regulatory history consistently sets forth a vision of a geologic repository as being one where waste is emplaced at significant depth -- i.e., hundreds of meters below the ground surface. This history also consistently describes a geologic repository as consisting of a surface facility connected by shafts to an underground facility covering a few thousand acres wherein waste would be emplaced. This vision contrasts significantly with GCD borehole disposal at NTS, where waste has been emplaced in 10-foot diameter shafts at depths ranging from 70 to 120 feet below the ground surface.

Therefore, there is no compelling basis for concluding that the GCD boreholes constitute a type of geologic repository disposal within the context of 40 CFR 191 and its published guidance (current Appendix C of 40 CFR 191). Nonetheless, the boreholes are clearly subject to the Part 191 standard which applies to any land-based disposal system except for Yucca Mountain.

[19] This reference is to DOE's GEIS ROD which announced the national focus on geologic repositories for disposal of high-level and TRU waste and described a geologic repository as a facility where waste would be placed at depths of about 600 to 1000 meters below the ground surface.

[20] e.g., see Dickman, P.T., "Greater Confinement Disposal Test at the Nevada Test Site, Final Technology Report," SAIC for REECO, January 1989.

ATTACHMENT 2

When Does "Disposal" Take Place in the Context of 40 CFR 191.14?

For purposes of borehole disposal at NTS, we believe that the term "disposal" in 40 CFR 191.02 can be interpreted in different ways. Therefore, the interpretation of "disposal" for purposes of 40 CFR 191.14, "Assurance requirements," is a matter of judgement by DOE in its role as implementing agency for the standard. Based on our review of the standard, the rulemaking record, and the specific situation of borehole disposal at NTS, we recommend that "disposal" for purposes of compliance with 40 CFR 191.14 can be assumed to take place at the time that disposal facility closure has been completed.

As discussed below, this interpretation is reasonable considering the development of 40 CFR 191 and of 10 CFR 60 under the authority, among other statutes, of the Nuclear Waste Policy Act (NWPA). It is consistent with the approach used for performance assessments performed by DOE for LLW disposal facilities and by NRC for commercial LLW disposal facilities.

NWPA and Part 191 history. The NWPA was enacted to provide for the development of repositories for the disposal of high-level radioactive waste and spent nuclear fuel. House Report No. 97-491 describes the House's envisioned process for determining the acceptability of a repository for such waste. The House report outlines a process whereby NRC would grant DOE a construction authorization based on an initial determination of repository suitability. During construction and waste emplacement, additional observations and tests would occur to assure that the system's behavior corresponds to predicted behavior. The House thought that a period of observation could last from 10 to 30 years, and that "not until the Commission and other participants are satisfied of the safety of the system will the repository be backfilled with mined material and closed up permanently."

When 40 Part 191 was originally proposed prior to enactment of the NWPA, disposal was defined as "isolation of radioactive wastes with no intent to recover them" [47 FR 58205]. For the final version of Part 191, promulgated after enactment of the NWPA, the definition of disposal waste changed to: "permanent isolation of spent nuclear fuel or radioactive waste from the accessible environment with no intent of recovery, whether or not such isolation permits the recovery of such fuel or waste. For example, disposal of waste in a mined geologic repository occurs when all of the shafts to the repository are backfilled and sealed" [50 FR 38084].

Part 191 was issued with the intent of compliance with the NWPA. For this reason, "disposal" for purposes of a mined geologic repository is defined as occurring not when waste is initially

emplaced, but when all the shafts to the repository are backfilled and sealed. (In terms of 10 CFR Part 60, this would occur during "permanent closure" of a repository -- see below.) This interpretation would not preclude some backfilling to occur within the repository during its operation -- for example, backfilling around emplaced waste containers to provide for radiation shielding. The standard is silent about the interpretation of "disposal" for other disposal methods.

10 CFR 60. Part 60 addresses disposal of HLW and spent nuclear fuel in geologic repositories, and inter alia, implements the requirements of 40 CFR 191. For purposes of performance assessment, NRC expects that active institutional controls would not be relied upon for longer than 100 years following permanent closure of the repository. Permanent closure involves sealing of shafts and would be expected to occur many years (e.g., up to 50 years) after initial waste emplacement.

LLW disposal. For disposal of LLW by DOE under DOE 5820.2A, or commercial LLW disposal facilities under 10 CFR 61 (or compatible Agreement State regulation), performance assessments for purposes of compliance consider an assumed 100-year active institutional control period. For both sets of requirements, the 100-year period is assumed to commence not when waste is first emplaced, but after final closure of the disposal facility. In commenting on NRC's proposed Part 61 rule, EPA supported NRC's position that the 100-year period would occur following "transfer of control of the disposal site to the owner" (which occurs following disposal facility closure).[1]

Conclusion. For purposes of compliance with 40 CFR 191.14, the Part 191 definition of "disposal" can be interpreted in more than one way -- particularly in regard to disposal methods other than geologic repositories. But for purposes of the NTS TRU waste boreholes, "disposal" may be construed as occurring when all planned engineered barriers have been installed -- i.e., at final disposal facility closure. This interpretation for the purposes of 40 CFR 191.14 is reasonable considering the history of the NWPA and the development of Part 191 and 10 CFR 60. It is compatible with the approach used for performance assessments for disposal of LLW. It is reasonable and realistic considering that the TRU waste boreholes are located within an area where LLW and mixed LLW disposal will continue to take place well into the future.

[1] See U.S. Nuclear Regulatory Commission, "Final Environmental Impact Statement on 10 CFR Part 61, "Licensing Requirements for Land Disposal of Radioactive Waste," NUREG-0945, Vol. 2, November 1982, p. B-440.

ATTACHMENT 3

Appropriate Use of Published EPA Guidance (Appendix C of Existing 40 CFR 191)

EPA has issued implementation guidance for Part 191 as Appendix C of the current standard. Although we recommend that NVO generally follow this guidance for preparation of the GCD PA, special consideration is necessary for interpretation of certain portions of it -- namely, those paragraphs addressing "consideration of inadvertent intrusion into geologic repositories" and "frequency and severity of inadvertent intrusion into geologic repositories."

As discussed in Attachment 1 of this guidance, when EPA developed the 1985 version of the standard, EPA justified the achievability of meeting the standard solely in terms of waste disposal in mined geologic repositories. Nonetheless, Part 191 is applicable to any land-based disposal system other than Yucca Mountain. When issuing the 1985 version of the standard, EPA published accompanying guidance as Appendix B of the standard. This guidance states: "Most of this guidance applies to any type of disposal system... However, several sections apply only to disposal in mined geologic repositories and would be inappropriate for other types of disposal systems." When EPA developed the 1993 version of the standard, EPA again justified the achievability of the standard solely in terms of waste disposal in mined geologic repositories, although EPA again applied the standard to any land-based disposal system. EPA did not revisit the guidance except to change it to Appendix C.

It is therefore necessary to interpret the guidance considering that the GCD boreholes cannot be reasonably construed to be a type of geologic repository (see Attachment 1). No background information on the development of the EPA guidance is available in the rulemaking docket. Nonetheless, based on our review of the EPA guidance and the rulemaking record, we believe that reasonable interpretations can be made for purposes of the GCD boreholes. In so doing, we distinguish those portions of the EPA guidance that seem to be either applicable to any disposal method or provide a general philosophical outlook, from those portions of the EPA guidance that seem to be narrowly focused on geologic repositories.

Accordingly, we recommend that all but two paragraphs of the EPA guidance be considered directly applicable to the GCD boreholes. These latter two paragraphs require special consideration as discussed below. For these paragraphs we first state the EPA guidance and then provide an interpretation for application to the GCD boreholes.

Consideration of Inadvertent Human Intrusion into Geologic Repositories.
Statement of EPA guidance: *The most speculative potential disruptions of a mined geologic repository are those associated with inadvertent human intrusion. Some types of intrusion would have virtually no effect on a repository's containment of waste. On the other hand, it is possible to conceive of intrusions (involving widespread societal loss of knowledge regarding radioactive wastes) that could result in major disruptions that no reasonable repository selection or design precautions could alleviate. The Agency believes that the most productive consideration of inadvertent intrusion concerns those realistic possibilities that may be usefully mitigated by repository design, site selection, or use of passive controls (although passive institutional controls should not be assumed to completely rule out the possibility of intrusion). Therefore, inadvertent and intermittent intrusion by exploratory drilling for resources (other than any provided by the disposal system itself) can be the most severe intrusion scenario assumed by the implementing agencies. Furthermore, the implementing agencies can assume that passive institutional controls or the intruder's own exploratory procedures are adequate for the intruders to soon detect, or be warned of, the incompatibility of the area with their activities.*

Application to Boreholes: The first four sentences of the EPA paragraph provide an overall philosophical approach to addressing intrusion analyses. These sentences observe, among other things, that inadvertent intrusion is speculative, that it is possible to conceive of intrusions that no reasonable repository selection or design precautions could alleviate, and that the most productive consideration of inadvertent intrusion concerns those realistic possibilities that may be usefully mitigated by design, site selection, or passive controls. These observations represent reasonable guidance for disposal of waste into any disposal system and are therefore appropriate for the GCD boreholes.

The fifth sentence of the EPA paragraph addresses the most severe type of intrusion event considered reasonable for a geologic repository -- namely, inadvertent and intermittent intrusion by exploratory drilling for resources. This sentence must be interpreted for the boreholes. Considering the location of the boreholes within the NTS and the depth of waste emplacement, we consider it unlikely that there could be a plausible expectation of many other types of human intrusion, if any, that could significantly affect the disposal system. Still, because the waste is closer to the surface than would be waste in a geologic repository, further consideration is warranted.

We believe that when identifying possible intrusion events for purposes of analysis, an important principle for doing so should be to identify those realistic possibilities that may be usefully mitigated by disposal system location or design, or passive institutional controls. (This principle is derived from the fourth sentence of the EPA paragraph.) For example, a well hypothetically constructed for purposes of exploration for water resources might be considered realistic; and if needed, there may be disposal system design features that may be considered that could reduce the likelihood of such intrusion (e.g., abruptly sloping surface features). In this case, the intrusion

event might be considered useful for making closure decisions for the boreholes.

On the other hand, complete excavation of an extensive area within the Area 5 RWMS -- such as construction of a basement for a sports complex or for open pit mining -- might be construed as being either unrealistic or not usefully mitigated by disposal system location or design, or passive institutional controls, and therefore not useful for purposes of making a closure decision (e.g., such a scenario might require the assumption that all design measures would be assumed to be bypassed, an assumption that could be made for any disposal system, anywhere). Additional considerations may be (1) whether there are any resources that can be identified today in quantities sufficient to justify consideration of a surface mining scenario, or (2) whether it would be likely that a large hypothetical excavation would result in other waste or radioactive material being contacted long before the TRU waste would be contacted. For such a hypothetical event, the sixth sentence of the EPA paragraph may be instructive to consider.

Furthermore, it may be reasonable to consider that relatively low-cost intrusion events, such as drilling, are probably more likely than high-cost ones, such as extensive construction. The more extensive an assumed construction project, the more likely that an intruder would try to protect the investment by searching records and performing other investigations before construction begins.

In any event, we fall back on our general guidance to consider the disposal system on its own merits, and to base its primary justification for identification of reasonably plausible intrusion scenarios on the basis of site-specific conditions, informed judgement, or other appropriate rationale. NVO may be able to make use of information that addresses the same or similar issues for other wastes disposed at the NTS site.

The sixth sentence of the guidance states that implementing agencies may assume that passive institutional controls or the intruder's own exploratory procedures are adequate for intruders to soon detect, or be warned of, the incompatibility of the area with their activities. This sentence is reasonable for application to the GCD boreholes. There is nothing in the sentence that is obviously restricted to geologic repositories. Rather, it is consistent with guidance provided elsewhere in Appendix C that appears to apply to any disposal method. Furthermore, the principles expressed in the sentence are compatible with NRC assumptions for development of the waste classification system for 10 CFR 61.

Frequency and Severity of Inadvertent Human Intrusion into Geologic Repositories.

Statement of EPA guidance: ***The implementing agencies should consider the effects of each particular disposal system's site, design, and passive institutional controls in judging the likelihood and consequences of such inadvertent exploratory drilling. However, the Agency assumes that the likelihood of such inadvertent and intermittent drilling need not be taken to be greater than 30 boreholes per square kilometer of repository area per 10,000 years for geologic repositories in proximity to sedimentary rock formations, or more than 3 boreholes per square kilometer per 10,000 years for repositories in other geologic formations. Furthermore, the Agency assumes that the consequences of such inadvertent drilling need not be assumed to be more severe than: (1) direct release to the land surface of all the ground water in the repository horizon that would promptly flow through the newly created borehole to the surface due to natural lithostatic pressure -- or (if pumping would be required to raise water to the surface) release of 200 cubic meters of ground water pumped to the surface if that much water is readily available to be pumped; and (2) creation of a ground water flow path with a permeability typical of a borehole filled by the soil or gravel that would normally settle into an open hole over time -- not the permeability of a carefully sealed borehole.***

Application to boreholes: This paragraph contains three sentences: one general and two specific. Each is addressed.

The first sentence provides fundamental guidance that is applicable to any disposal system, including the GCD boreholes. This guidance states that implementing agencies should consider the effects of each particular disposal system's site, design, and passive institutional controls in judging the likelihood and consequences of inadvertent exploratory drilling. However, we would broaden the guidance in that it provides a basic approach applicable to any reasonably plausible intrusion event, not just drilling.

The second sentence appears to be more narrowly focused on mined geologic repositories. It provides numerical limits on the frequency of drilling for resources that need be assumed for geologic repositories. The stated numerical limits were apparently derived from generic assessments made by EPA when it developed the rule. Because these assessments pertained specifically to geologic repositories, it is difficult to regard them as being directly applicable to the GCD boreholes. We also observe that the stated limits are in terms of "sedimentary rock formations" and "other geologic formations," which do not appear to describe the situation for the GCD boreholes which involves waste disposal in alluvial sediments. [1]

Therefore, we recommend that NVO fall back on our overall guidance to consider the disposal system based on its own merits. NVO should base its primary justification for determination of intrusion frequency on site-specific

[1] Also of considerable interest are EPA statements on drilling assumptions on page 2-18 of U.S. EPA, "High-Level and transuranic Radioactive Wastes, Response to Comments for Amendments to 40 CFR Part 191," EPA 402-R-93-072, December 1993.

conditions, informed judgement, or other appropriate rationale. However, the numerical intrusion frequencies stated in the EPA guidance can certainly be used for purposes of comparison and perspective.

The third sentence also appears to be narrowly focused on mined geologic repositories. It addresses two of the three pathways resulting from a well-drilling intrusion event that EPA considered when it justified the achievability of the 1985 standard. The third pathway is release of cuttings to the accessible environment assuming that a drill bit directly strikes a container of waste. Because cuttings from drilling directly through a waste container are not mentioned in the EPA guidance, it has been questioned whether cuttings should be considered for possible intrusion, via a well drilling scenario, into the GCD boreholes.

Our recommendation is that for purposes of 40 CFR 191.13, release of cuttings should be considered in intrusion analyses involving well-drilling scenarios. It is clear that EPA considered and included the release of cuttings when it judged the achievability of the standard. Hence, there is no compelling rationale for not considering the cuttings for purposes of the GCD boreholes. Although it is unclear why the cuttings were not included in the list of release pathways, we believe that a plausible explanation is that for the generic geologic repositories originally analyzed by EPA, the calculated cancer risks over 10,000 years were small for release of cuttings compared to the other pathways considered in EPA's analyses. Although the consequences of a drill contacting a waste container were large in terms of released contamination, the probability of doing so was small enough that the overall risks were relatively small. But because such an analysis of overall risks has not been prepared for the boreholes, it would be inappropriate to *a priori* exclude the cuttings from consideration.

Our recommendation, then, is to consider the consequences of drilling into a borehole, and to multiply the consequences by the probabilities of doing so in accordance with the requirements of 40 CFR 191.13. The probability for a single drilling event might be determined by first estimating the probability of drilling within that disposal area set aside within the Area 5 RWMS by DOE for permanent control and identified by permanent markers, and then estimating the probability that a drilling event within this permanently controlled area contacts a borehole.

Appendix H
Code of Federal Regulations, Title 40, Part 141

(relevant excerpts as of January 19, 1994)

CODE OF FEDERAL REGULATIONS
TITLE 40--PROTECTION OF ENVIRONMENT
CHAPTER I--ENVIRONMENTAL PROTECTION AGENCY
SUBCHAPTER D--WATER PROGRAMS
PART 141--NATIONAL PRIMARY DRINKING WATER REGULATIONS
SUBPART B--MAXIMUM CONTAMINANT LEVELS

s 141.15 Maximum contaminant levels for radium-226, radium-228, and gross alpha particle radioactivity in community water systems.

The following are the maximum contaminant levels for radium-226, radium-228, and gross alpha particle radioactivity:

(a) Combined radium-226 and radium-228--5 pCi/1.

(b) Gross alpha particle activity (including radium-226 but excluding radon and uranium)--15 pCi/1.

s 141.16 Maximum contaminant levels for beta particle and photon radioactivity from man-made radionuclides in community water systems.

(a) The average annual concentration of beta particle and photon radioactivity from man-made radionuclides in drinking water shall not produce an annual dose equivalent to the total body or any internal organ greater than 4 millirem/year.

(b) Except for the radionuclides listed in Table A, the concentration of man-made radionuclides causing 4 mrem total body or organ dose equivalents shall be calculated on the basis of a 2 liter per day drinking water intake using the 168 hour data listed in "Maximum Permissible Body Burdens and Maximum Permissible Concentration of Radionuclides in Air or Water for Occupational Exposure," NBS Handbook 69 as amended August 1963, U.S. Department of Commerce. If two or more radionuclides are present, the sum of their annual dose equivalent to the total body or to any organ shall not exceed 4 millirem/year.

TABLE A--AVERAGE ANNUAL CONCENTRATIONS ASSUMED TO PRODUCE A TOTAL BODY OR ORGAN DOSE OF 4 MREM/YR

Radionuclide	Critical organ	pCi per liter
Tritium	Total body	20,000
Strontium-90	Bone marrow	8

Appendix I
Example Calculation of the Normalized Cumulative Release for the 40 CFR 191.13 Containment Requirements

This appendix provides example calculations of cumulative release limits for the containment requirements of the Environmental Protection Agency (EPA) of 40 CFR 191 for the inadvertently disposed, transuranic inventory in Trench T04C of the Area 5 Radioactive Waste Management Site on the Nevada Test Site.

Step 1:Determine the inventory of the specific disposal system.

Identify the total activity of radionuclides in waste packages meeting the definition of TRU waste (see below). This is the 40 CFR 191.13 regulated waste inventory for the specific disposal system (Table I).

40 CFR 191.02(i) Definition of transuranic radioactive waste: Waste containing more than 100 nCi of alpha-emitting transuranic isotopes with half-lives greater than 20 years, per gram of waste.

Table I. Example inventory of radionuclides in TRU waste packages in Trench TO4C on October 1, 2028 (see Table 2.5 from Schott et al. 2007)

Nuclide	Activity (Ci)	Nuclide	Activity (Ci)	Nuclide	Activity (Ci)
Tl-207	6.0E-08	Po-218	1.1E-08	Th-232	4.2E-14
Tl-208	9.6E-15	At-217	4.1E-11	Th-234	3.5E-03
Tl-209	8.8E-13	Rn-219	6.0E-08	Pa-231	1.3E-07
Pb-209	4.1E-11	Rn-220	2.7E-14	Pa-233	3.5E-04
Pb-210	3.5E-09	Rn-222	1.1E-08	Pa-234m	3.5E-03
Pb-211	6.0E-08	Fr-221	4.1E-11	Pa-234	5.6E-06
Pb-212	2.7E-14	Fr-223	8.3E-10	U-233	3.1E-08
Pb-214	1.1E-08	Ra-223	6.0E-08	U-234	3.5E-03
Bi-210	3.5E-09	Ra-224	2.7E-14	U-235	1.5E-04
Bi-211	6.0E-08	Ra-225	4.1E-11	U-236	3.3E-05
Bi-212	2.7E-14	Ra-226	1.1E-08	U-238	1.2E-07
Bi-213	4.1E-11	Ra-228	3.0E-14	Np-237	3.5E-04
Bi-214	1.1E-08	Ac-225	4.1E-11	Pu-238	2.6E+00
Po-210	3.5E-09	Ac-227	6.0E-08	Pu-239	9.0E+01
Po-211	1.6E-10	Ac-228	3.0E-14	Pu-240	2.0E+01
Po-212	1.7E-14	Th-227	5.9E-08	Pu-241	2.2E+01
Po-213	4.0E-11	Th-228	2.7E-14	Pu-242	1.3E-03
Po-214	1.1E-08	Th-229	4.1E-11	Am-241	2.7E+01
Po-215	6.0E-08	Th-230	1.2E-06		
Po-216	2.7E-14	Th-231	1.5E-04	Total	1.6E+02

Step 2. Calculate the total activity of nuclides governed by the TRU waste definition

The Appendix A Table I release limits of the EPA 40 CFR 191 are scaled based on the total activity of TRU waste nuclides. The sum of the total activity of radionuclides meeting the definition of TRU waste is 140 Ci (highlighted in Table II).

Table II. Total activity of TRU waste nuclides

Nuclide	Activity (Ci)	Nuclide	Activity (Ci)	Nuclide	Activity (Ci)
Tl-207	6.0E-08	Po-218	1.1E-08	Th-232	4.2E-14
Tl-208	9.6E-15	At-217	4.1E-11	Th-234	3.5E-03
Tl-209	8.8E-13	Rn-219	6.0E-08	Pa-231	1.3E-07
Pb-209	4.1E-11	Rn-220	2.7E-14	Pa-233	3.5E-04
Pb-210	3.5E-09	Rn-222	1.1E-08	Pa-234m	3.5E-03
Pb-211	6.0E-08	Fr-221	4.1E-11	Pa-234	5.6E-06
Pb-212	2.7E-14	Fr-223	8.3E-10	U-233	3.1E-08
Pb-214	1.1E-08	Ra-223	6.0E-08	U-234	3.5E-03
Bi-210	3.5E-09	Ra-224	2.7E-14	U-235	1.5E-04
Bi-211	6.0E-08	Ra-225	4.1E-11	U-236	3.3E-05
Bi-212	2.7E-14	Ra-226	1.1E-08	U-238	1.2E-07
Bi-213	4.1E-11	Ra-228	3.0E-14	Np-237	3.5E-04
Bi-214	1.1E-08	Ac-225	4.1E-11	**Pu-238**	**2.6E+00**
Po-210	3.5E-09	Ac-227	6.0E-08	**Pu-239**	**9.0E+01**
Po-211	1.6E-10	Ac-228	3.0E-14	**Pu-240**	**2.0E+01**
Po-212	1.7E-14	Th-227	5.9E-08	Pu-241	2.2E+01
Po-213	4.0E-11	Th-228	2.7E-14	**Pu-242**	**1.3E-03**
Po-214	1.1E-08	Th-229	4.1E-11	**Am-241**	**2.7E+01**
Po-215	6.0E-08	Th-230	1.2E-06		
Po-216	2.7E-14	Th-231	1.5E-04	**Total TRU**	**1.4E+02**

Step3. Calculate the release limit scaling factor for the specific disposal system

Calculate the scaling factor for the release limits as the ratio of the total TRU waste nuclide activity over the reference amount of waste (e.g., 1E6 Ci for the TRU waste category).

$$SF = \frac{1.4E+02\ Ci}{1.0E+06\ Ci} = 1.4E-4$$

Step 4. Scale the Appendix A Table I release limits using the scaling factor.

The Appendix A Table I release limits are multiplied by the scaling factor to obtain the scaled release limits for the specific disposal system (Table III).

Table III. Appendix A Table I release limits and scaled release limits for the specific disposal system

Radionuclide	Appendix A Table I Release Limit (Ci per 1 x 10^6 Ci of TRU Waste)	Scaled Release Limit (Ci per 1.4 x 10^2 Ci of TRU Waste)
Am-241 or Am-243	100	1.4E-2
C-14	100	1.4E-2
Cs-135, Cs-137	1,000	1.4E-1
I-129	100	1.4E-2
Np-237	100	1.4E-2

Pu-238, Pu-239, Pu-240, or Pu-242	100	1.4E-2
Ra-226	100	1.4E-2
Sr-90	1,000	1.4E-1
Tc-99	10,000	1.4E+0
Th-230 or Th-232	10	1.4E-3
Sn-126	1,000	1.4E-1
U-233, U-234, U-235, U-236, or U-238	100	1.4E-2
Any other alpha-emitting radionuclide with a half-life greater than 20 yrs	100	1.4E-2
Any other radionuclide with a half-life greater than 20 yrs that does not emit alpha particles	1,000	1.4E-1

Step 5. Identify nuclides in the specific disposal system that have release limits

Identify radionuclides in the specific disposal system that are listed in Appendix A Table 1 or have half-lives greater than 20 years. Using Table III, determine the scaled release limit for each nuclide having a release limit (Table IV).

Table IV. Scaled release limits for the specific disposal system

Nuclide	Scaled Release Limit (Ci)	Nuclide	Scaled Release Limit (Ci)	Nuclide	Scaled Release Limit (Ci)
Tl-207	No Limit	Po-218	No Limit	Th-232	1.4E-03
Tl-208	No Limit	At-217	No Limit	Th-234	No Limit
Tl-209	No Limit	Rn-219	No Limit	Pa-231	1.4E-02
Pb-209	No Limit	Rn-220	No Limit	Pa-233	No Limit
Pb-210†	1.4E-02	Rn-222	No Limit	Pa-234m	No Limit
Pb-211	No Limit	Fr-221	No Limit	Pa-234	No Limit
Pb-212	No Limit	Fr-223	No Limit	U-233	1.4E-02
Pb-214	No Limit	Ra-223	No Limit	U-234	1.4E-02
Bi-210	No Limit	Ra-224	No Limit	U-235	1.4E-02
Bi-211	No Limit	Ra-225	No Limit	U-236	1.4E-02
Bi-212	No Limit	Ra-226	1.4E-02	U-238	1.4E-02
Bi-213	No Limit	Ra-228	No Limit	Np-237	1.4E-02
Bi-214	No Limit	Ac-225	No Limit	Pu-238	1.4E-02
Po-210	No Limit	Ac-227†	1.4E-02	Pu-239	1.4E-02
Po-211	No Limit	Ac-228	No Limit	Pu-240	1.4E-02
Po-212	No Limit	Th-227	No Limit	Pu-241	No Limit
Po-213	No Limit	Th-228	No Limit	Pu-242	1.4E-02
Po-214	No Limit	Th-229	1.4E-02	Am-241	1.4E-02
Po-215	No Limit	Th-230	1.4E-03		
Po-216	No Limit	Th-231	No Limit		

† Low yield alpha emitter

Step 6. Calculate the normalized cumulative release

The normalized cumulative release is calculated as:

$$R = \sum_{i=1}^{n} \frac{Q_i}{RL_i} \qquad \text{(Eq. 1)}$$

where R is the normalized cumulative release (dimensionless), Q_i the cumulative release over 10,000 years of nuclide i obtained from the performance assessment model (Ci), and RL_i the scaled release limit of nuclide i (Ci) from Table IV. Performance of the disposal system is simulated repeatedly producing a probability mass function (pmf) for the normalized cumulative release. The probability of R greater than 1 and 10 is determined from the simulated pmf and compared with the CR probability limits of 0.1 and 0.001 for R>1 and R>10, respectively (Figure 1).

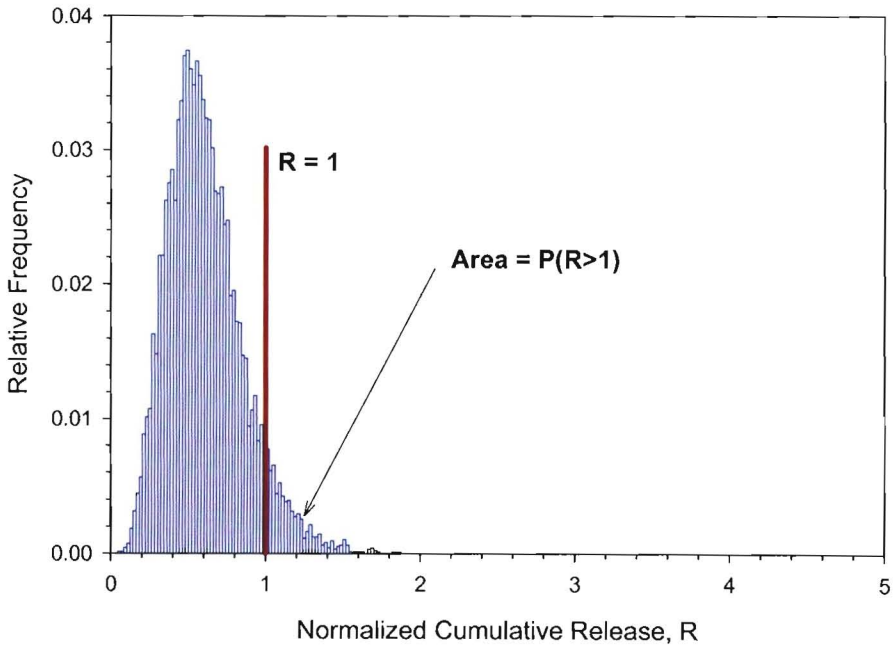


Fig. 1. Simulated probability mass function for R showing the probability of R>1. The 40 CFR 191.13 CRs limit the P(R>1) to less than 0.1.